THE TELEGRAPHIC JOURNAL AND

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## TECHNICAL EDUCATION.

We have now before us, dated March 13th, 1882, the Report to the Governors of the City and Guilds of London Institute for the advancement of technical education; and as electrical engineering—with Prof. W. E. Ayrton as principal of this department—forms an important item in the course of study at the Cowper Street Schools, we believe a reference to the progress made in this branch of science will not be uninteresting to our readers. The report states that, "notwithstanding the want of accommodation in the temporary classrooms at Cowper Street, which this year (1881) has been seriously felt, the number of students attending the day and evening classes has steadily increased. A great impulse has been given to the teaching of Technical Physics by the general interest manifested in the subject of electricity in its application to lighting and to machinery. The classes of Prof. Ayrton on 'Electric Lighting and Transmission of Power' and 'Electrical Instrument making,' have been so well attended that it has been necessary to make arrangements for providing additional tutorial assistance in order that his students might receive the individual attention they require. During the past session, 551 tickets of admission to the evening classes on Technical Physics have been sold, showing a considerable increase on the attendance last year." We congratulate Prof. Ayrton on the success which he has already achieved, and which we feel assured will be highly developed in the immediate future. We may here glance at the course of study for students attending evening classes and lectures. That devoted to electrical instrument making embraces practical instruction in the scientific principles underlying the manufacture and testing of condensers, induction coils, and telephones; the principles of submarine duplex telegraphy, with the construction and use of artificial cables, are also included.

The students have the opportunity of performing for themselves the experiments suggested at the lectures, and Prof. Ayrton personally explains any technical difficulties attending the subject to those who choose to avail themselves of a special laboratory course. These lectures are delivered on Monday evenings.

On Wednesday evenings Prof. Ayrton discourses on the electric light, particularly drawing attention to the various forms of machines employed, and to the laws governing their action and efficiency. The lecturer criticises the different systems of electric lighting now used in London. He also enters into the practical application of the principles of the electric transmission of power to electric railways. Students can also have the advantage of special laboratory teaching, and the various methods of measuring electric currents, the illuminating power of electric lights produced by different degrees of current strength, &c., are practically dealt with by the pupils themselves. On Friday evenings a course of lectures is being delivered on a classified series of electrical experiments, which have been arranged to enable students to verify the fundamental principles and laws in electricity and magnetism.

The syllabus of the course on electrical laboratory apparatus is a most attractive and exhaustive one. We will not touch upon the day lectures and classes, as it is more than probable that most of our young readers who might benefit by such class instruction could only attend the City and Guilds Institute during the evening. That the future tuition in all branches of electrical science will be as complete as possible, may be inferred from the fact of Professor Ayrton's late visit to some of the principal technical laboratories in Germany, for the purpose of securing the best available arrangements and fittings.

It is proposed that telegraphy, electric lighting and transmission of power, and electrical instrument making shall all be grouped under one head, with the name of "Electrical Engineering." This is in consequence of the great and increasing importance of industries connected with electrical science. The sub-committee has also suggested the advisability of periodical examinations in this subject. These would probably be of the two grades, Ordinary and Honours. The first applies principally to apprentices and journeymen, the latter to foremen, managers, &c., but candidates could enter for either grade.

Without going so far at present as some enthusiasts who have declared that in a short time everything that we do now by a variety of means will be accomplished by employing electricity alone, we can state without fear of contradiction, that electrical engineering will take an exceptionally prominent place in the industries of the world. In telegraphy, telephony and electric-lighting only is it greatly developed, but there is no reason to doubt the success of its application to an almost infinite extent as we advance. Even now sufficient has been done to show the necessity of a better understanding of the principles and laws of electrical science on the part of those engaged in the ever increasing demand for electrical appliances. Looking at telegraphy and telephony alone, there is not so much room for complaint regarding the skill and knowledge of engineers, operators and workmen; for the majority employed in these two branches are doubtless of some years standing, and must have acquired at least a decent knowledge of electricity. But since the introduction of the electric light, a number of persons have been, if we may use the term, thrown into contact with the electrical profession, and it is to these that such technical instruction as that provided under the direction of Professor Ayrton will be of the greatest service. It must be remembered that the science of electricity in all its variety forms perhaps the most difficult and at the same time most interesting department of engineering, and as its development will be very rapid, there is no time to be lost on the part of those who are desirous of obtaining a thorough knowledge of this subject; and in this, as in any other matter, it will be found absolutely necessary that the elements should be assiduously studied. Professor Silvanus Thompson, in the course of his first lecture at the Crystal Palace Electrical Exhibition, remarked, that "If England desired that her workmen should rise to the immense future before them, they must at once be provided with an education in matters electrical, seeing that a knowledge of electric

currents and their properties will be of far more practical importance than a knowledge of any other branch of science."

It has been reserved for the City and Guilds Institute to initiate the first practical step on an extended scale towards technical education, and we trust and believe that the results so far have been eminently satisfactory. We have not been able to do more than give a hurried glance at the report from which we have noted a few items for the benefit of some of our readers, but we have said sufficient to make it apparent that the great desideratum of the past and present is now in a fair way of being supplied, and that, as far as the profession we represent is concerned, the teaching could not well be excelled.

## ELECTRIC LIGHTING BY INCANDESCENCE.

Abstract of Lecture delivered by Mr. J. W. SWAN at the Royal Institution on the evening of March 10th.

SPEAKING in this place on electric light, I cannot forget, nor forbear to mention, as inseparably associated with the subject and with the Royal Institution, the familiar illustrious names of Davy and Faraday. It was in connection with this Institution that eighty years ago the first electric light experiments were performed by Davy, and it was also in connection with this Institution that, forty years later, the foundations of the methods by means of which electric lighting has been made useful were strongly laid by Faraday.

When an arc electric light is produced, the conditions which surround the process are such as render it impossible to obtain a small light with proportionally small expenditure of power. In order to sustain the arc in a state approaching stability, a high electromotive force and a strong current are necessary. When an attempt is made to produce a smaller centre of light by the employment of a proportionally small amount of electrical energy, the mechanical difficulties of maintaining a stable arc, and the diminution in the amount of light (far beyond the diminished power employed), put a stop to reduction at a point at which much too large a light is produced for common purposes.

The often-repeated question, "Will electricity supersede gas?" could be promptly answered if we were confined to this method of producing electric light; and for the simple reason that it is impossible by this method to produce individual lights of moderate power.

The arc is totally unsuited for domestic lighting, and for nine-tenths of the other purposes for which artificial light is required. If electricity is to compete successfully with gas in the general field of artificial lighting, it is necessary to find some other means of obtaining light through its agency. Our hope centres in the method of producing light by electrical incandescence.

The fate of electricity as an agent for the production of artificial light in substitution of gas, depends greatly on the success or non-success of this method; for it is the only one yet discovered which adapts itself with anything like completeness to all the purposes for which artificial lighting is required.

If we are able to produce light economically through the medium of electrical incandescence in small quantities, or in large quantities, and at a cost not exceeding the cost of the same amount of gas light, then there can be little doubt—there can, I think, be *no* doubt—that in such a form, electric light has a great future before it.

When an electrical current traverses a conducting wire, a certain amount of resistance is opposed to the passage of the current. The amount of heat developed depends on the nature of the wire—on its length and thickness—and on the strength of the current which it carries. If the wire be thin and the current strong it may become white hot.

A principle, the importance of which cannot well be over estimated, underlies this method of producing light electrically—namely, the principle of *divisibility*. By means of electric incandescence it is possible to produce exceedingly small centres of light, even so small as that of the light of a single candle; and with no greater expenditure of power, in proportion to the light produced, than is involved in the maintenance of light-centres 10 or 100 times greater. Given a certain kind of wire, for example platinum, the 100th of an inch in diameter, a certain quantity of current would make this wire white-hot, whatever its length. If in one case the wire were one inch long, and in another case ten inches long, the same current passing through these two pieces of similar wire would heat both to precisely the same temperature. But in order to force the same current through the ten times longer piece, ten times the electromotive force, or, if I may be allowed the expression, electrical pressure, is required, and exactly ten times the amount of energy would be expended in producing this increased electromotive force.

Considering, therefore, the proportion between power applied and light produced, there is neither gain nor loss in heating these different lengths of wire. In the case of the longer wire, as it had ten times the extent of surface, ten times more light was radiated from it than from the shorter wire, and that is exactly equivalent to the proportional amount of power absorbed.

This is extremely important; for not only does it make it possible to produce a small light where a small light is required, without having to pay for it at a higher rate than for a larger light, but it gives also the great advantage of obtaining equal distribution of light.

In order to practically apply the principle of producing light by the incandescence of an electrically heated continuous solid conductor, it is necessary to select for the light-giving body a material which offers a considerable resistance to the passage of the electric current, and which is also capable of bearing an exceedingly high temperature without undergoing fusion or other change.

The high electrical resistance of platinum, and its high melting point, mark it out as one of the most likely of the metals to be useful in the construction of incandescent lamps. When platinum is mixed with ten or twenty per cent. of iridium, an alloy is formed which has a much higher melting point than platinum, and many attempts have been made to employ this alloy in electric lamps. But these attempts have not been successful, chiefly because high as is the melting point of iridio-platinum, it is not high enough to allow of its being heated to a degree that would yield a sufficiently large return in light for energy expended. Before an economical temperature is reached, iridio-platinum wire slowly volatilises and breaks. This is a fatal fault, because in obtaining light by incandescence there is the greatest imaginable advantage in being able to heat the incandescing body to an extremely high temperature. This becomes evident when it is remembered that a strong current is required to raise a wire to even a red heat, and that, when so heated, it emits scarcely any light. The power absorbed in producing heat up to that point is thrown away in so far as production of light is concerned. If the current which made the wire red-hot be doubled in quantity, the wire will become white-hot, and then it will emit an appreciable amount of light.

To make this important point still clearer, I have here arranged on the table a number of platinum wires, of the same thickness though not of equal length. I have arranged them so that the current is first seen effective in heating one wire, then that is split up into $\frac{1}{2}$, then into $\frac{1}{4}$, then into $\frac{1}{8}$. You see when I force the same current through these different lengths that the glow emitted is in inverse proportion to the length. I have here an arrangement connected with a lamp into which I can pass a regulated current of electricity, which we measure by a unit which we call an ampère. You will see as I experiment that the light is produced as in the following table:—

| Current in Ampères. | Electromotive Force in Volts. | Candle-Power Produced. |
|---|---|---|
| ·5 | 35 | 0 (carbon red-hot, but no light) |
| 1·0 | 60 | 2 " " |
| 1·5 | 88 | 35 " " |

It will be observed that a considerable amount of current is used in heating the wire up to the temperature at which it begins to be incandescent, and it is only after that point is reached that the current becomes effective in the production of light. One unit of current passed through the filament will only make it red-hot. It is at zero as regards light. If the current be doubled, the light is at once raised to that of two candles. But one unit more of current at once raises the light to no less than 35 candles.

It will readily be understood from what I have shown, that it is essential to economy that the incandescing material should be able to bear an enormous temperature without fusion. There is a non-metallic substance which does so in an eminent degree: this is carbon. Carbon, as we commonly know it, is a brittle and non-elastic substance, possessing neither ductility nor plasticity to favour its being shaped suitably for use in an electric lamp. Yet, in order to render it serviceable for this purpose, it is necessary to form it into a slender filament, which must possess sufficient strength and elasticity to allow of its being firmly attached to conducting wires, and to prevent its breaking. If heated white-hot in the air, carbon burns away, and therefore means must be found for preventing its combustion. It must either be placed in an atmosphere of some inert gas or in a vacuum.

During the last forty years, spasmodic efforts have, from time to time, been made to grapple with the many difficulties which surround the use of carbon as the wick of an electric lamp. It is only within the last three or four years that these difficulties can be said to have been surmounted. It is now found that carbon can be produced in the form of straight or bent filaments of extreme thinness, and possessing a great degree of elasticity and strength. Such filaments can be produced in various ways—by the carbonisation of paper, thread, and fibrous woods and grasses. Excellent carbon filaments can be produced from the bamboo, and also from cotton thread treated with sulphuric acid. The sulphuric acid treatment effects a change in the cotton thread similar to that which is effected in paper in the process of making parchment paper, and results finally in the production of very dense carbon. In carbonising these materials it is of course necessary to preserve them from contact with the air. This is done by surrounding them with charcoal.

Here is an example of a carbon filament produced from parchmentised cotton thread. The filament is not more than the ·01 of an inch in diameter, and yet a length of three inches, having therefore a surface of nearly the one-tenth of an inch, gives a light of twenty candles when made incandescent to a moderate degree.

I have said, that in order to preserve these slender carbon filaments from combustion, they must be placed in a vacuum; and experience has shown that if the filaments are to be durable, the vacuum must be exceptionally good. One of the chief causes of failure of the earlier attempts to utilise the incandescence of carbon, was the imperfection of the vacua in which the white-hot filaments were placed; and the success which has recently been obtained is in great measure due to the production of a better vacuum in the lamps.

The invention of the mercury pump by Dr. Sprengel, and the publication of the delicate and beautiful experiments of Mr. Crookes in connection with the radiometer, revealed the conditions under

which a really high vacuum could be produced, and in fact gave quite a new meaning to the word vacuum. It was evident that the old incandescent lamp experiments had not been made under suitable conditions as to vacuum; and that before condemning the use of carbon, its durability in a really high vacuum required still to be tested. This idea having occurred to me, I communicated it to Mr. Stearn, who was working on the subject of high vacua, and asked his co-operation in the endeavour to obtain durability in the carbon filaments of electric lamps by producing a better exhaustion of the bulb containing the carbon. After much experimentation, the result was at last arrived at that when a well-formed carbon filament is firmly connected with conducting wires, and placed in a hermetically sealed glass ball, perfectly exhausted by the Sprengel pump, the filament suffers no apparent change even when heated to an extreme degree of whiteness. I am bound to say that Mr. Edison had the same idea, and reached the same conclusion as Mr. Stearn and myself.

A necessary condition of the higher vacuum was the simplification of the lamp. In its construction there must be as little as possible of *any* material, and there must be none of such material as could occlude gas, which being eventually given out would spoil the vacuum. There must besides be no joints except those made by the glass-blower.

Therefore, naturally and perforce of circumstances, the incandescent carbon lamp took the most elementary form, resolving itself into a simple bulb, pierced by two platinum wires supporting a filament of carbon. Probably the first lamp, having this elementary character, ever exhibited was shown in operation at a meeting of the Literary and Philosophical Society of Newcastle in October, 1877. The vacuum had been produced for me by Mr. Stearn by means of an improved Sprengel pump of his invention, a specimen of which is on the table.

The pump exhibited was a form of the ordinary mercurial exhaust pump, in which the exhaustion was carried on by means of drops of mercury falling rapidly through the receiver, and carrying minute bubbles of air along with them. The lecturer stated that the process could be carried on till the air was exhausted down to $\frac{1}{1,000,000}$ of its original capacity.

Blackening of the lamp glass, and speedy breaking of the carbons, had been such invariable accompaniments of the old conditions of imperfect vacua, and of imperfect contact between carbon and conducting wires, as to have led to the conclusion that the carbon was volatilised. But under the new conditions these faults entirely disappeared, and carefully conducted experiments have shown that well-made lamps are quite serviceable after more than a thousand hours' continual use; and when the manufacture is better understood, I have no doubt that they will be serviceable for a very much longer period.

The heat produced is comparatively very small. This is conclusively shown by the slowness with which water is heated when a lamp is immersed in it. I have here a lamp fitted especially for use in mines. The current may be supplied either through main wires from a dynamo-electrical machine, with flexible branch to the lamp, or it may be fed by a set of portable store cells closely connected with it.

I may, I think, fairly say that the difficulties encountered in the construction of incandescent electric lamps have been completely conquered, and that their use is economically practicable. In making this statement I mean that, both as regards the cost of the lamp itself and of supplying electricity to illuminate it, light can be produced at a cost which will compare not unfavourably with the cost of gas light. It is evident that if this opinion can be sustained, lighting by electricity at once assumes a position of the widest public interest, and of the greatest economic importance; and in view of this, I may be permitted to enter with some detail into a consideration of the facts which support it.

There has now been sufficient experience in the manufacture of lamps to leave no doubt that they can be cheaply constructed, and we know by actual experiment that continuous heating to a fairly high degree of incandescence during 1,200 hours does not destroy a well-made lamp. What the utmost limit of a lamp's life may be, we really do not know. Probably it will be an ever-increasing span; as, with increasing experience, processes of manufacture are sure to become more and more perfect. Taking it, therefore, as fully established that a cheap and durable lamp can now be made, the further question is as to the cost of the means of its illumination.

This question in its simplest form is that of the more or less economical use of coal, for coal is the principal raw material alike in the production of gas and of electric light. In the one case, the coal is consumed in producing gas which is burnt; in the other, in producing motive power, and, by its means, electricity.

The cost of producing light by means of electric incandescence may be compared with the cost of producing gas light in this way. Two cwt. of coal produces 1,000 cubic feet of gas, and this quantity of gas, of the quality called fifteen-candle gas, will produce 3,000 candle light for one hour. But besides the product of gas, the coal yields certain bye products of almost equal value. I will therefore take it that we have in effect 1,000 feet of gas from one cwt. of coal instead of from two, as is actually the case.

And now, as regards the production of electricity. The one cwt. of coal—that is the same measure as gives 1,000 feet of gas—will give fifty horse-power for one hour. Repeated and reliable experiments show that we can obtain through the medium of incandescent lamps at least 200 candle light per horse-power per hour. But as there is waste in the conversion of motive power into electricity, and also in the conducting wires, we make a liberal deduction of twenty-five per cent., and take only 150 candle light as the net available product of one horse-power. For fifty horse-power, the produce of one cwt. of coal, we have then 7,500 candle light, as against 3,000 candle light from 1,000 feet of gas. That is to say, two and a half times the amount of light which the gas from the same quantity of coal is capable of producing.

There still remains, however, an allowance to be made to cover the cost of the renewal of lamps. There is a parallel expense in connection with gas lighting in the cost of the renewal of gas burners, gas globes, gas chimneys, &c. I cannot say that I think these charges against gas lighting will equal the corresponding charges against electric lighting, unless we import into the account—as I think it right to do—the consideration that without a good deal of expense is incurred in the way of renewal of burners, and unless minute attention be given, far beyond what is actually given, to all the conditions under which the gas is burned—nothing like the full light product which I have allowed to be obtainable from the burning of 1,000 cubic feet of gas will be obtained, and, as a matter of fact, is not commonly obtained, especially in domestic lighting. Taking this into account, and considering what would have to be done to obtain the full yield of light from gas, and that if it be not done, then the estimate I have made is too favourable, I think but little, if any, greater allowance need be made for the charge in connection with the renewal of lamps in electric lighting than ought to be made for the corresponding charges for the renewal of gas burners, globes, chimneys, &c. But it will be seen that even if the cost for renewal of lamps should prove to be considerably greater than the corresponding expense in the case of gas, that there is a wide margin to meet them before we have reached the limit of the cost of gas lighting.

I think, too, it may be fairly taken into account, and placed to the credit of electric lighting, that by this mode of lighting there is entire avoidance of the damage to furnishings and decorations of houses, to books, pictures, and to goods in shops, which is caused through lighting by gas, and which entails a large expenditure for repair, and a large amount of loss which is irreparable.

I have based these computations of cost of electric light on the supposition that the light product of one horse-power is 150 candles. But if durability of the lamps had not to be considered, and it were an abstract question how much light can be obtained through the medium of an incandescent filament of carbon, then one might, without deviating from ascertained fact, have spoken of a very much larger amount of light as obtainable by this expenditure of motive power. I might have assumed double or even more than double the light for this expenditure. Certainly double and treble the result I have supposed can actually be obtained. The figures I have taken are those which consist with long life to the lamps. If we take more light for a given expenditure of power, we shall have to renew the lamps oftener, and so what we gain in one way we lose in another. But it is extremely probable that a higher degree of incandescence than that on which I have based my calculations of cost may prove to be compatible with durability of the lamps. In that case, the economy of electric lighting will be greater than I have stated.

In comparing the cost of producing light by gas and by electricity, I have only dealt with the radical item of coal in both cases. Gas lighting is entirely dependent upon coal—electric lighting is not; but in all probability coal will be the chief source of energy in the case of electric lighting also. When, however, water power is available, electric lighting is in a position of still greater advantage, and, in point of cost, altogether beyond comparison with other means of producing light.

To complete the comparison between the cost of electric light and gas light, we must consider not only the amount of coal required to yield a certain product of light in the one case and in the other, but also the cost of converting the coal into electric current and into gas; that is to say, the cost of manufacture of electricity and the cost of manufacture of gas. I cannot speak with the same exactness of detail on this point as I did on the comparative cost of the raw material. But if you consider the nature of the process of gas manufacture, and that it is a process, in so far as the lifting of coal by manual labour is concerned, not very unlike the stoking of a steam boiler, and if electricity is generated by means of steam, then the manual labour chiefly involved in both processes is not unlike. It is evident that in gas manufacture it would be necessary to shovel into the furnaces and retorts five or six times as much coal to yield the same light product as would be obtainable through the steam engine and incandescent lamps. But here again it is necessary to allow for the value of the labour in connection with the products other than gas, and hence it is right to cut down the difference I have mentioned to half—*i.e.*, debit gas with only half the cost of manufacture, in the same way as in our calculation we have charged gas with only one half the coal actually used. But when that is done, there is still a difference of probably three to one in respect of labour in favour of electric lighting.

I have made these large allowances of material and labour in favour of the cost of gas, but it is well known that the bye products are but rarely of the value I have assumed. I desire, however, to allow all that can be claimed for gas.

With regard to the cost of plant, I think there will be a more even balance in the two cases. In a gas works you have retorts and furnaces, purifying chambers and gasometers, engines, boilers, and appliances for distributing and regulating pressure. Plant for generating electricity on a large scale would consist principally of boilers, steam engines, dynamo-electric machines, and batteries for storage.

No such electrical station, on the scale and in the complete form I am supposing, has yet been put into actual operation; but several small stations for the manufacture of electricity already exist in England, and three large stations designed by Mr. Edison are, if I am rightly informed, almost completed in America. We are therefore on the point of ascertaining by actual experience what the cost of the works for generating electricity will be. Meanwhile, we know precisely the cost of boilers and engines, and we know approximately what ought to be the cost of dynamo-electric machines of suitably large size. We have, therefore, sufficient grounds for concluding that to produce a given quantity of light electrically the cost of plant would not exceed greatly, if at all, the cost of equivalent gas plant.

There remains to be considered, in connection with this part of the subject, the cost of distribution. Can electricity be distributed as widely and cheaply as gas? On one condition, which I fully hope can be complied with, this may be answered in the affirmative. The condition is that it be found practicable and safe to distribute electricity of comparatively high tension.

The importance of this condition will be understood when it is remembered that to effectively utilise electricity in the production of light in the manner I have been explaining, it is necessary that the resistance in the carbon of the lamps should be relatively great to the resistance in the wires which convey the current to them. When lamps are so united with the conducting wire that the current which it conveys is divided amongst them, you have a condition of things in which aggregate resistance of the lamps will be very small, and the conducting wire, to have a relatively small resistance, must either be very short, or, if it be long, it must be very thick, otherwise there will be excessive waste of energy; in fact, it would not be a practical condition of things.

In order to supply the current to the lamps economically, there should be comparatively little resistance in the line. A waste of energy through the resistance of the wires of ten or perhaps twenty per cent. might be allowable, but if the current is supplied to the lamps in the manner I have described—that of multiple arc, each lamp being as it were a crossing between two main wires, then—and even if the individual lamps offered a somewhat higher degree of resistance than the lamps now in actual use—the thickness of the conductor would become excessive if the line was far extended. In a line of half a mile, for instance, the weight of copper in the conductor would become so great, in proportion to the number of lamps supplied through it, as to be a serious charge on the light. On the other hand, if a smaller conducting wire were used, the waste of energy and consequent cost would greatly exceed that I have mentioned as the permissive limit.

Distribution in this manner has the merit of simplicity; it involves no danger to life from accidental shock; moreover, it does not demand great care in the insulation of the conductor. But it has the great defect of limiting within comparatively small bounds the area over which the power for lighting could be distributed from one centre. In order to light a large town electrically on this system, it would be necessary to have a number of supply stations, perhaps half a mile apart. It is evidently desirable to be able to effect a wider distribution than this, and I hope that either by arranging the lamps in series, so that the same current passes through several lamps in succession, or by means of secondary voltaic cells, placed as electric reservoirs in each house, it may be possible to economically obtain a much wider distribution.

Whether by the method of multiple arc, which necessitates the multiplication of electrical stations, or by means of the simple series, or by means of secondary batteries connected with each other from house to house in single series, the lamps being fed from these in multiple arc, I am quite satisfied that, comparatively with the distribution of gas, the distribution of electricity is sufficiently economical to permit of its practical application on a large scale.

As to the cost of laying wires in a house, I have it on the authority of Sir Wm. Thomson, who has just had his house completely fitted with incandescent lamps from attics to cellars—to the entire banishment of gas—that the cost of internal wires for the electric lamps is less than the cost of plumbing in connection with gas pipes.

I have expended an amount of time on the question of cost which I fear must have been tedious, but I have done so from the conviction that the practical interest of the matter depends on this point. If electric lighting by incandescence is not an economical process, it is practically unimportant; but if it can be established—and I have no doubt that it can—that this mode of producing light is economical, the subject assumes an aspect of the greatest importance.

Although at the present moment there may be deficiencies in the apparatus for generating and storing electricity on a very large scale, and but little experience in distributing it for lighting purposes over wide areas, and consequently much yet to be learnt in these respects; yet if once it can be clearly established that, light for light, electricity is as cheap as gas, and that it can be made applicable to all the purposes for which artificial light is required, electric light possesses such marked advantages in connection with health, with the preservation of property, and in respect of safety, as to leave it as nearly certain as anything in this world can be, that the wide substitution of the one form of light for the other is only a question of time.

## ELECTRIC LIGHTING BY INCANDESCENCE.

### II.

*(Continued from page 74.)*

WHEN a wire is heated by the passage of a current it becomes hotter and hotter as the current is kept on, but all the time the heat generated becomes dispersed by *radiation*, and the greater the temperature the greater is the rate at which this loss by radiation takes place; when the rate of loss of heat becomes equal to the rate of supply, the temperature becomes constant. According to experiments made by Dulong and Petit the loss by radiation varies as the square of the increase of the temperature above the temperature of the surrounding atmosphere, *i.e.*, for example, if one wire be raised 100°, and another 200° above the temperature of the surrounding medium, then the rate at which the loss of heat will take place in the two cases will be as

$$100^2 : 200^2$$

or as

$$1 : 4$$

in other words, the hotter of the two wires will throw out four times as much heat in a given time as the one at the lower temperature.

Now the heat generated in a wire traversed by a current depends directly upon the resistance of the wire; if then we have two wires which are heated by the same current, one to an increase of temperature of 100°, and the other to an increase of temperature of 200°, then since in the latter case four times as much heat is being thrown out by radiation than is thrown out in the first case, it must be evident that four times as much heat is being generated in one case as in the other, and as the heat generated is dependent directly upon the resistance of the wires it therefore follows that whilst the temperatures are in the proportion of 1 to 2, the resistances must be in the proportion of 1 to 4, or as 1 to $2^2$. In other words, the resistances of the two wires must be in proportion to the squares of the temperatures of the two wires. If then R and $R_1$ be the resistances of the two wires when the latter are elevated by temperatures, $t$ and $t_1$ respectively, we must have

$$\frac{R}{R_1} = \frac{t^2}{t_1^2} \qquad (A)$$

Before proceeding further in our investigation, we would draw attention to a somewhat erroneous statement made in the first article on page 73. It was there stated that one cause of the different temperatures to which wires of different metals become heated when traversed by the same current was the difference in the *specific heat* of the metals. Although this reason is given in text books on electricity,* it is entirely erroneous. It would be quite true if we suppose that the current is kept on for a short period only, and if it were taken off before the wires had assumed the highest temperature to which they could be heated by a continuous current, and provided there were no loss by radiation. It is only when bodies are heated by a definite amount of heat that the question of specific heat comes into account. If heat be continually supplied until the metal become as it were saturated, then its capacity for heat cannot affect the temperature to which it will become raised; the heat becomes poured in as it were until the pressure, *i.e.*, the radiation, causes it to pour out as quickly as it is poured in. The rate at which radiation takes place depends upon the nature of the surface from which the heat pours out; if the surface is the same the rate of radiation is the same. To explain the matter clearer, let us suppose that we have a mass of copper and a mass of platinum of exactly the same dimensions and with their surfaces blackened (say) over, and suppose that these two masses were placed at equal distances from a source of heat, then at first the platinum would rise in temperature above the copper, because although both have received an equal amount of heat, yet the heat in one case has a greater power of producing an elevation of temperature than in the other; after a time, however, the temperature of the copper would creep up to that of the platinum, and finally the two would have exactly the same temperature, showing that the heat coming in is exactly equivalent to the heat being radiated out. The specific heat, in fact, now does not affect the phenomena taking place.

On page 74 (Article I.) we had two formulæ

$$R = r \times 2^{\frac{t}{455}}$$

and

$$R_1 = r_1 \times 2^{\frac{t_1}{255}}$$

which show the change of resistance which will take place in a platinum and a copper wire by change of temperature. Now

$$\frac{R}{R_1} = \frac{r \times 2^{\frac{t}{455}}}{r_1 \times 2^{\frac{t_1}{255}}}$$

* See "Electricity and Magnetism," by Silvanus P Thompson. Page 332, for example.

If then we substitute the value of $\frac{R}{R_1}$ given in equation (A) we have

$$\frac{t^2}{t_1^2} = \frac{r \times 2^{\frac{t}{455}}}{r_1 \times 2^{\frac{t_1}{235}}}$$

Let us now suppose that by the passage of a current the platinum wire in a chain formed of alternate links of platinum and copper has become heated to incandescence, that is, to about 2,500° F. above the normal temperature of the atmosphere, to what temperature would the copper be heated? We have

$$\frac{2500^2}{t_1^2} = \frac{5{\cdot}6 \times 2^{\frac{2500}{455}}}{1{\cdot}0 \times 2^{\frac{t_1}{235}}} = \frac{252{\cdot}46}{1{\cdot}0042^{t_1}}$$

5·6 and 1·0 being the relative specific resistances of platinum and copper (see p. 73); therefore

$$\frac{t_1^2}{1{\cdot}0042^{t_1}} = \frac{625000}{252{\cdot}45} = 24757$$

The value of $t_1$ in this equation is best found by the trial method, *i.e.*, giving different values to $t_1$, until such a value is found as will satisfy the equation. If we make $t_1 = 209$, we have

$$\frac{t_1^2}{1{\cdot}0042^{t_1}} = \frac{43681}{1{\cdot}0042^{209}} = 24750$$

showing that while the platinum has increased its temperature 2,500°, the copper has only increased by 209°.

Let us now compare platinum and carbon, and let us suppose that the carbon has become heated to 2,500°, we have in this case

$$\frac{t^2}{2500^2} = \frac{5{\cdot}6 \times 2^{\frac{t}{455}}}{\frac{6500}{2^{\frac{2500}{2500}}}} = {\cdot}0017231 \times 1{\cdot}0015^t$$

therefore

$$\frac{t^2}{1{\cdot}0015^t} = 1076{\cdot}9$$

If we make $t = 34°$, we get

$$\frac{t^2}{1{\cdot}0015^t} = 1097{\cdot}7$$

which approximately satisfies the equation.

We see then that carbon becomes far more highly heated than the platinum by the passage of the current.

(*To be continued.*)

## LEGISLATION FOR CABLE PROPERTY.

WITH reference to the above subject we have already published a considerable amount of information, and in the issue of December 15th last have especially advocated a law to protect the rights of first comers. Recently we have received an interesting extract from a book entitled "Queensland the Progressive," by Mr. J. C. White, who passed forty years in Australia. It contains a definition of a "squatter," from which we take the first two paragraphs :—

A squatter is any person who occupies a tract of country called a run on Government land for grazing purposes, and stocks it with sheep, cattle, or horses.

*In the early days of the colony, a man who had capital wherewith to purchase stock, formed an expedition into the bush, and after surveying the country and finding a locality suitable for his purpose, combining good pasture ground with plenty of water, all he had to do was to forward a description of the natural or marked boundaries, with an estimate of the extent, to the commissioner of crown lands, who issued an order authorising occupation. No one could interfere with him, and very extensive tracts of country were thus taken up. These pioneers of civilisation had many difficulties and hardships to contend with, they were subject to the depredations of the aboriginal natives and white bush rangers, or runaway convicts, who frequented the bush, and in many cases lives were sacrificed in defence of property.*

Submarine cable property in its present stage is, according to our way of thinking, in the same position as that described in these two paragraphs, with the important difference that instead of the cables being laid over Government lands they occupy what was no man's land until they came. Referring again to the instance of one cable being laid over another, the later comer cannot do this without at least coming into contact with the first comer, and this contact must depreciate the value of the property of the "first comer." Take as an instance a ship anchored, even in what are known as the free seas, no other ship is allowed to come into contact with the first come ship without being held responsible for the damage done. In this case the space occupied for the time being by the first ship is to all intents and purposes the property of the first ship, and that right would be fully recognised in a court of law. As the cable when laid down occupies a certain previously unclaimed space, the same reasons which we have applied to shipping would in all probability be held to be legal when applied to submarine telegraph property, so much so that in a collision, so to speak, of two telegraph cables, the cable causing the damage or depreciation should bear the financial sequence. This damage can only be caused by the later comer, and consequently all depreciation in value of the property of the first comer should be borne by the later arrival.

In his able address to the shareholders of the Submarine Telegraph Company, Sir James Carmichael, on the 22nd ult., said that the Admiralty Court had supported a claim made by the Submarine Telegraph Company against a vessel which had wilfully damaged one of their cables. This would indicate that existing laws will support any claim for indemnity on account of wilful damage or depreciation to cable property.

Nevertheless, a clearer understanding on the matter is desirable, and we are glad to see that M. de Freycinet, the French Prime Minister, has issued invitations to the different maritime powers of Europe, calling on them to send representatives to an international conference on all questions connected with submarine telegraphy. At this conference, we have little doubt, the right of first comers will receive considerable attention.

In the meantime it would be well did the management of existing lines, in view of the approaching legislation, keep matters in *statu quo* and not resign any of their rights as first comers. As pointed out in our number of the 18th ult., the German Union Company intend laying next month a cable to connect Valentia with Greetsiel. The question of damage or depreciation to existing lines which will be caused by this new line is a serious one, involving several thousand pounds, and should receive considerable attention from the owners of the existing lines.

The coming conference will probably deal with questions of this kind, and should the present laws leave any doubt as to the claim for indemnity being entertained, the matter will then be clearly settled. Until then at least it will be advisable for the existing lines to take every precaution to have this an open question when the conference sits.

## UNDERGROUND CONDUCTORS.

A CORRESPONDENT in the United States writes to us as follows :—

"The great commercial demand upon electrical inventors of to-day is for a successful underground conductor or system of conductors, such that the disagreeable Morse ticking may not be heard in telephones, and that our cities may be freed from great rows of unsightly poles decked with noisy humming wires, which make by their vibrations the night hideous to all within hearing distance when Boreas chooses to convert them into Æolian harps. This demand opens up a field necessarily fruitful to successful inventors, and it has not lacked for a supply, if not equal to the occasion, at least willing to make the effort. The first in the field to show anything like good results was a Philadelphian named Brooks, who adopted a return wire for the circuit in close proximity to and insulated from the wire which carried the advanced circuit. This, however, was old before Mr. Brooks' independent invention, and was patented in England as early as 1854. If two wires of equal cross section and equal length are placed near each other and connected in one circuit, reduced inductive effects are noticed. This is doubtless due to the fact that electrical induction is similar in its action to heat, and radiates through space from the wires in lines of secants. So that there is a line parallel to the two wires, and immediately between them, where the inductive effects are neutralised, and hence the whole effect is diminished in its nature. All

other lines of induction must necessarily cross each other at angles varying from 0° to 90° on either side of this line of no inductive effects, and hence it follows if one wire have placed about it an infinite number of such wires we would expect no inductive effects. As a matter of experiment, I think such would be the fact, provided the total resistance of the exterior wires equals that of the interior conductor. But another difficulty occurs, viz., the inductive effects of these exterior wires among themselves. This, however, may be so small for ordinary distances as to be inappreciable. A cylindrical exterior conductor of equal resistance to the interior wire might be used. But all of these plans are open to the objection of exterior radiation. If a cylinder is used exterior to the central conductor, there results no effect so far as the central conductor is concerned, but the balance must be disturbed by exterior radiation before mentioned. Another mode suggests itself. Let there be a series of exterior cylinders, and let these cylinders be connected alternately in pairs to the battery. That is to say, let there be a common central conductor of given resistance and insulated. Exterior to that let there be a series of insulated cylinders increasing in resistance as we pass from the centre outward, such that the total resistance of these cylinders equals that of the central wire. Let the central wire at the receiving station be connected in multiple arc to the exterior cylinders, and the receiver be in the single wire.

"Then at the transmitting station let the battery be connected in multiple arc; that is to say, let the plus pole pass to the central conductor, the minus pole to the first concentric shell; the plus pole to the next exterior, and the minus to the next, and so on alternately. In this way we would have a statical balance: each exterior shell being of higher resistance, would compensate its corresponding interior shell inductively. Of course the ratio of distances between the shells would need to be accurately estimated, and the inductive capacity of the insulating material compensated for. In theory this number of exterior shells would need to be infinite, to compensate a perfect conductor. But in practice a point might be attained when the static capacity of the exterior shell would be very low, and when this point was reached good results might be expected. Dr. Lugo, a chemist and electrician of great merit, of N. Y. City, has devised another system decidedly ingenious in its nature, and as far as tested apparently entirely satisfactory in its results. He makes the return circuit part a solenoidal conductor about the advance circuit, the solenoid circuit being of the same resistance as the central conductor. If two circuits cross at right angles no inductive effect is felt. In other words, the inductive effect varies directly as the cosine of the angle of inclination. Taking advantage of this fact, Dr. Lugo has devised a conductor which has been tested by Mr. F. L. Pope, and I glean from his report the startling fact that with a telephone in the solenoid circuit, and an electric light in a dynamo circuit parallel and in close proximity, no sounds were heard, while on ordinary parallel circuits with earth connections the noise was unbearable. Mr. Pope's printed report upon tests of this cable is very interesting, and may, I think, be fully relied upon, as he is an electrician of undoubted integrity. But to revert to the construction of this cable. Inasmuch as the solenoid must be of large sectional area to give it the same resistance as the axial wire, it becomes impossible to wind them exactly at right angles. The Doctor compensates for this difficulty by alternating the conductors, that is, by making the cable in links and reversing their order. In this way it is entirely possible to eliminate the horizontal components which result in winding a long cable, and to make in theory the currents pass each other at absolute right angles.

"Here as before, however, occurs the same trouble as in the multiple series of exterior conductors of which I before spoke. There must result an inductive effect between the coils of the exterior or solenoidal conductor, and I think in long cables this will be seriously felt. This may be overcome by making the solenoid of a bundle of small insulated wires, and connecting them in multiple arc as before, and with this arrangement a more perfect cable than has yet been made would result.

"In conclusion, one word with regard to balanced circuits. Mr. Varley, with wonderful sagacity, saw years ago the advantage of balanced circuits, and his English patents of ten years past fully describe such. It seems to me that the successful telephonic and telegraphic systems for long distances in the future must be upon this plan, and with Lugo's plan of conductors as above suggested. I don't see why long distance telephony may not be a success. It must certainly be easier to transmit a signal by destroying a dynamic balance than by setting up a current in an unbalanced system. I throw this out as a suggestion, and shall perhaps have occasion in a future article to give more particularly my reasons in connection with a series of experiments made by Mr. C. E. Buell, of New Haven, Connecticut, and show how he was enabled to receive telephonic signals with balanced batteries over distances quadruple those possible with the well-known single current charging methods now in existence."

## THE BAUDOT TELEGRAPH.

(*Continued from page* 159.)

THE armatures of the five electro-magnets presenting by their positions the exact representation of the respective situations given to the keys of the manipulator, a system of correspondence is formed. If, for example, the first key alone represents when in action the letter A, the second the letter B, and so on with the others, the third, fourth, and fifth keys alone representing the letters C, D, and E; the first and second keys when displaced together might represent the letter F, and so on with the other combinations of 2, 3, &c., of the five keys, each of these combinations, the total number of which is 31, representing a different letter. At the corresponding station we might, by observing the five armatures, see which among them have been displaced and brought into contact with their working stop, thus indicating the key, or combination of keys, displaced at the starting point, and consequently the letters of the alphabet transmitted. But it is evident that the reading of the signals in a system of this kind would be very difficult, and would indeed become impossible as soon as they succeeded each other somewhat rapidly. To obviate this M. Baudot introduces an apparatus to which he has given the name of combiner, which represents in printed characters each of the combinations which, having been formed by the keys of the manipulator at the starting point, are reproduced by the armatures at the point to which they are transmitted. Fig. 3 shows the principle of this apparatus.

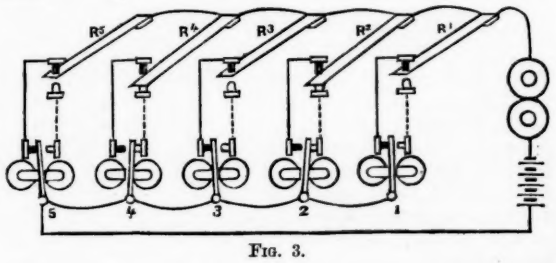


FIG. 3.

Opposite to each of the armatures of the receiving electro-magnets is shown a spring free to oscillate between two stops. The armatures, springs, and stops being electrically connected, the circuit of the battery can only be open if the five springs are simultaneously in communication respectively with the five armatures; so that if one or more of these have been displaced, in order to break the circuit and consequently raise the pallet of the electro-magnet, the springs opposite to them must be lowered—that is to say, with these springs must be formed the combination which has been made with the armatures.

Each of the five armatures of the receptive electro-magnets being regulated so as to remain in the position in which the last current received has placed it, the combination formed will remain, and will be exactly reproduced by the springs, even if by any process the 31 combinations which it is possible to make should be formed successively. The electro-magnet will release its pallet at one moment or another at the time of coincidence of position between the springs and the armatures; and this moment being different,

according to the combination of armatures displaced, will serve to determine the printing of the letters that these combinations are intended to represent.

The apparatus which performs these different operations is the electric combiner. It works automatically five levers or springs, each of which can be put into communication either with the stop of rest or the stop of action of the armature corresponding, and thus reproduces the 31 combinations that can be formed. The result of this operation is to break the circuit of a local battery through an electro-magnet, and consequently to effect the raising of the pallet at the time when the combiner reproduces on its springs the combination prepared by the armatures, and at that moment only.

M. Baudot has conceived several forms of the electric combiner. In one arrangement the five springs of the combiner are disposed parallel to one another and each one fixed at one extremity. The free end can oscillate between two stops, but in its normal state rests upon the upper one by the effect of elasticity. These springs can be displaced and brought in contact with the lower stop by means of cams fixed upon a cylinder turning below them, as in the hand organs, in which a cylinder furnished with cams regulates the vents of the instrument.

If the cams are properly arranged on the cylinder, in one revolution of it the five springs can effect successively the 31 combinations. On the prolongation of the axis of the cylinder is a wheel of type, which presents to the paper each of its letters in proportion as the combinations by which they are represented are executed by the spring. As soon as the combination formed by the armatures, and which in the alphabet adopted represents this letter, is reproduced by the springs of the combiner, the local circuit will be opened, and the raising of the pallet can be utilised for projecting the paper to be printed on the letter presented to it by the wheel.

The electric combiner can be varied by supposing that the spring, instead of being fixed, slides over a row of contacts connected beforehand with the stop of the armature, so that it may be in communication with the stop of action during its passage over sixteen of the divisions, and with the stop of rest during its passage over the fifteen other divisions. The relations between the springs and the stops of the armatures are in this case determined by their rubbing over the contacts connected in advance with these stops, whereas in the before-mentioned arrangement the result was attained by cams resting on these springs and putting them in communication with stops connected with those of the armatures. In each case the same result is obtained.

The electric combiners require a great number of communications and contacts, hence they necessitate a considerable amount of attention and care in order to obtain regular and exact working. M. Baudot has obviated this difficulty by employing mechanical combiners.

In this system the rubbing springs extend over the series of contacts forming concentric circles. The pieces of metal and pieces of insulated material placed alternately, which serve to combine these contacts, are replaced by a succession of raised and hollow intervals which meet the rubbing springs. The combination is realised when the five springs fall simultaneously into a hollow, causing a movement of the frame which bears them, and consequently a mechanical action equal to the raising of the pallet, and capable of producing the impression. Each of these springs can be moved at will into either of the two circles by means of a system of points analogous to that employed on railways; the action of the levers of these little points being determined by the armature of the corresponding receiving electro-magnet, or, more exactly, by an intermediate armature worked by a relay. There are ten rows of circles for the five rubbers. We shall at some future time describe the mechanical combiner more fully. The transmission of a letter, *i.e.*, the reproduction at destination by the five armatures of the combination, effected by means of the five keys of the manipulator at the starting point, is performed in a comparatively short space of time. This is the only time that the line is used, for the work of the combiner is local, and leaves the line free. It was natural to utilise the principle of multiple transmission that we have described, so as to make a more complete use of the line. On the circumference of the distributors are inserted several series of five contacts each, each series connected with a manipulator, a group of five electro-magnets, and a combiner.

The reader is now able to judge of the efforts M. Baudot has made to perfect his apparatus. We have, however, merely glanced at the subject. There were in addition problems to be solved with regard to synchronism under particularly difficult conditions, the mechanism to be regulated being massive and complicated.

There were also difficulties to be obviated arising from the phenomena always produced in charging long lines. As an example of this, let us suppose two machines to be in communication, and let us consider a combination in which the first, third, and fourth keys are lowered. The first electro-magnet will work under the influence of the positive current emitted by the first key. The negative current sent automatically by the second key will then arrive at the second electro-magnet, but first it must destroy the positive charge in the line, and replace it by an equal and contrary one. Then the positive current sent by the third key arrives, which destroys this latter charge, and actuates the third electro-magnet by charging the line positively again. So far all is well, and the three currents sent thus in succession have found the line charged under the same conditions; but if the fourth key then sends a current which has no charge to destroy—and which, on the contrary, continues and augments the positive charge produced by the current of the third key—the fourth electro-magnet is then traversed by a current of greater force than the preceding ones. Now this irregularity in the intensity of the currents received renders the regulation of the electro-magnets very difficult and very delicate. These difficulties are increased by the fact that the positive charge which has to be destroyed by the negative current of the fifth key is more considerable, and thus the intensity of this current on its arrival is proportionately reduced.

These observations are evidently applicable to all the combinations in which the current sent by a key has been preceded by emissions either of the same kind or contrary. The longer the line or the greater the rapidity of the transmissions the greater are these inconveniences. They might be more or less diminished by inserting between each of the contacts of the distributor a contact connected to earth; but in this case the result obtained is diminished in proportion.

M. Baudot has applied to this problem a more elegant solution, borrowed from another apparatus, also very remarkable—Wheatstone's automatic telegraph. By this method the current sent by each key, of either kind, is automatically weakened either by overcoming resistance or by a derivation current, if the preceding key has sent a current of the same kind. To accomplish this it is sufficient to arrange the keys in such a manner as to make them take, in the preceding key, the positive or negative current which each must send along the line.

One last complication remained—the necessity of obtaining at the starting point a transmission of control. M. Baudot's apparatus supplies this desideratum satisfactorily.

We have finished the explanation of the principles of the apparatus; in a future article we shall commence the description in detail of the principal parts, manipulators, distributors, relays, combiners, and receivers.—*L'Electricien.*

CH. BONTEMPS.

## REVIEWS.

*Useful Information on Electric Lighting.* By KILLINGWORTH HEDGES, C.E. Third edition. Revised and enlarged. E. and F. N. Spon, Charing Cross.

ELECTRIC lighting has not yet reached such a state of perfection as to enable one to write a standard work on such a subject, for fresh systems and new arrangements of others are continually cropping up. The book in question by Mr. Hedges was written at the request of a few frends, who being interested in the subject wished for general information. The author states that his plan of proceeding was to condense into a very abridged form the principles governing magnets, currents, &c., and a general description of the arrangements necessary to carry these principles into practice. The work is intended for the use of public boards,

manufacturers, and those wishing to adopt the electric light. The present edition is the third, the book having been originally written four years ago, but Mr. Hedges has thought it necessary to re-write the whole, and many terms and formulæ are omitted which would be essential in a work of more scientific pretensions. We do not know how long the author has been connected with electrical science, and we must not express disapproval at new men entering the profession we represent, and we therefore welcome Mr. Hedges, but it would have been well had his modesty kept him from rushing into print until he had become better acquainted with the subject he professes to give useful information on. From the fact of the book having gone to a third edition, one would probably have expected that it had become an acknowledged work; if this is the case all we can say is that we are sorry for those persons who study the book with the view to obtaining accurate information on the subject with which the author professes to deal. Along with the book are given a number of extracts from reviews in such high scientific authorities as the *Perthshire Constitutional*, the *Dundee Advertiser*, &c. The *Journal of Applied Science* says—"This is a practical little treatise on the subject with which it deals by *one who thoroughly understands it*" (the italics are our own). As a specimen of the thorough knowledge which the author possesses of his subject we may quote the following, on page 3:—"A current which will draw a piece of iron into a coil, if reversed will repel it;" page 4, "In all modern machines the electricity is generated by having fixed magnets and causing the coils or bobbins to rotate." In referring to the Pilsen lamp the author says, "The inventor found that by making *two* plungers this shape (conical) and opposing one to the other in two solenoids, wound with thick and thin wire," &c.; a most accurate description, certainly! On page 18 we find, "In derivational lamps the regulative arrangements for burning in series are *independent of the strength of the current.*" On page 26 the following occurs: "The resistance of a good carbon 1 millimetre in diameter has been found to vary from 40 to 50 ohms per *millimetre.*" On page 28 we are told (a remarkable fact, certainly), that "the carbons of Siemens are of a hard nature and of high resistance, but can be employed with the currents supplied by their own machines." With reference to lead wires we are informed, on page 35, that "the leading wires from the machine should be of sufficient length to offer a resistance equal to the lamp or lamps." This, we think, is quite a new fact in electric lighting arrangements. Much useful information the book undoubtedly contains, but this is so mixed up with misleading and incorrect statements as to reduce its value very considerably. Before writing a fourth edition of his work we would strongly recommend Mr. Hedges to attend an elementary class on electricity; he may then possibly be able to treat the elementary parts of the subject with more intelligence than he has yet shown.

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*Berly's Electrical Directory and Advertiser*, 16, New Bridge Street, Blackfriars.

IN our issue of December 1st, 1881, we took notice of a specimen page of "Berly's Electrical Directory," and expressed an opinion then that, as far as we could judge, the arrangement was all that could be desired. Now that the book is completed we have great pleasure in endorsing our former judgment, and the highest praise we can bestow is that it ought to find a place in the libraries of all those either directly or indirectly connected with electrical science. Although not so complete as the next issue will be (a "Continental Directory" being in preparation for this), it will be found most interesting and highly useful now. Amongst its contents the "remarks on the past years" will be found to contain much information in a concise form. The "tables and formulæ" will be of use to practical engineers. Now that so much progress is developing in electrical science amongst all classes of manufacturers and engineers, the various "trades" and "professional" lists will be found very advantageous to those desiring to know to whom to apply for apparatus or information on any particular subject. A list of electrical publications, with publishers' names and prices will materially assist those studying electrical matters. The idea of such a manual is original, and its success is certain, for it is the only thing of the kind published, and it well supplies a long-felt want.

# EXPERIMENTS MADE WITH M. FAURE'S SECONDARY BATTERIES.

By MM. ALLARD, LE BLANC, JOUBERT, POTIER and TRESCA.

AT the sitting of Monday last, March 6th, Mr. Tresca presented to the Academy of Sciences the result of the experiments tried upon the Faure battery at the Conservatoire des Arts-et-Métiers, by MM. Allard, F. Le Blanc, Joubert, Potier and Tresca.

We give an extract of the principal facts in the original report.

A first experiment had been begun at the usual scene of our experiments at the exhibition on the 20th October, 1881, under the conditions prescribed and prepared by M. Faure. The battery consisted of 40 elements; it was constructed to work, during its discharge, 16 Maxim lamps, but the trial soon proved very unsatisfactory. The intensity of the current and that of the light decreased with very great rapidity. The experiment, begun at 7.40 p.m., with an intensity of 3·45 carcel burners per lamp, had to be stopped after one hour and 20 minutes, when each lamp gave no more than one carcel burner. M. Faure attributed this failure to defects in his installation and to the bad condition of the elements, 4 or 5 of which had in fact discharged themselves spontaneously during their working. The committee agreed to resume these experiments under whatever conditions and with whatever material M. Faure should judge most favourable for obtaining a better result. These experiments were performed at the Conservatoire des Arts-et-Métiers, in the large hall of machines in motion, on the 4th, 5th, 6th, 7th, and 9th of January, 1882, and these should be considered the continuation of those which had been commenced at the exhibition.

The battery, placed at the disposal of the committee, consisted of 35 elements, on a new model, with plates bent into a spiral, each weighing 43 kilo. 700, including liquid; the leaden electrodes were coated with minium in the proportion of about one kilogramme per square metre. The liquid of the batteries consisted of distilled water with the addition of $\frac{1}{10}$ of its volume of pure sulphuric acid.

The charging machine, also supplied by M. Faure, as agreed, was of the Siemens type. The resistance of the ring was 0·27 ohms, that of the inductor 19·45 ohms (*sic*). The electro-magnet was excited by a shunt taken at the very extremity of the machine; in order to regulate the exciting current, M. Faure employed a kind of voltameter with carbon electrodes, in which he caused the resistance to vary by altering the quantity or the nature of the liquid. During the entire duration of the experiment the exciting current by this means was limited to between two and three ampères.

The principal object of these experiments was to measure: I. The mechanical labour expended in charging the battery. II. The quantity of electricity stored up during the charge. III. The quantity of electricity given out during the discharge. IV. The electrical work actually effected during the discharge. It was besides necessary to know at every moment of the experiment the electromotive force and the resistance of the battery, and also, as the discharge was to be made through a series of incandescent Maxim lamps, to study the variation in resistance and luminous power of these lamps, according to the intensity of the current.

The mechanical work was measured by means of the absolute dynamometer constructed for the Society of Agriculturists of France, by Messrs. Easton and Anderson, on the model of that of the Royal Society of Agriculture of England.

The luminous intensity was taken with the Foucault photometer, which had been used for the other experiments of the committee. As to the electrical measurements, they were made by means of the three following instruments:—A Marcel-Deprez galvanometer, which measured the total current, and sometimes the exciting current; a Siemens' electro-dynamometer, which only measured the charging current, and an electrometer with dial-plate, disposed according to the method already indicated by M. Joubert, which showed the difference of potential between the two poles of the battery.*

The indications of all the instruments were taken simultaneously every quarter of an hour; during the latter part of the experiment, when the variations were more rapid, the readings were taken twice as often.

### *Calculation of the Mean Intensity and of the Quantity of Electricity.*

The mean intensity corresponding to a long interval of time is the arithmetical mean of the intensities taken every quarter of an hour during that time.

The product of the number of seconds occupied, and this mean intensity expressed in ampères, gives in coulombs the quantity of electricity put into action during the time in question.

| Dates. | Mean Intensities. | Seconds. | Coulombs. |
|---|---|---|---|
| January 4th ... | 10·930 | 19,800 | 216,400 |
| ,, 5th ... | 7·970 | 25,200 | 200,800 |
| ,, 6th ... | 7·936 | 27,000 | 214,300 |
| ,, 7th ... | 6·360 | 9,900 | 63,000 |

* In order to insure the most complete control of all the results obtained, the register remained, during the entire duration of the experiments, at the disposal of M. Faure. We did not consider that this concession would entitle him to publish any extract from it before the summing-up of the conclusions arrived at, and before the publication of our report.

The same calculation must be made in reference to the exciting current in order to serve as a basis for subsequent conclusions.

| Mean Intensities. | Seconds. | Coulombs. |
|---|---|---|
| 2·46 | 19,800 | 48,700 |
| 2·81 | 25,200 | 72,800 |
| 2·33 | 27,000 | 62,900 |
| 2·18 | 9,900 | 21,600 |

*Calculation of Electrical Work.*

As long as the difference of potential between the two extremities of the battery remains constant, the electrical work of the charge or of the discharge, corresponding to a given time, is equal to the product, divided by $g$, of the quantity of electricity, and this difference of potential. When the latter varies, we must multiply each intensity by the corresponding difference of potential, then divide by $g$, and take the arithmetical mean of all the results.

It is by this method that the figures in the 8th and 9th columns of the first table have been obtained and also those in the 5th column of the second table.

The 8th column represents the electrical work, T′, expended in order to introduce into the battery the quantities of electricity received during the charge.

*Electrical Work during the Charge.*

| | Difference of Potential. | Quantity of Electricity. | Corresponding Work. |
|---|---|---|---|
| January 4th | 82·21 | 216,400 | 1,814,600 |
| ,, 5th | 91·08 | 200,800 | 1,947,100 |
| ,, 6th | 92·91 | 214,300 | 2,028,800 |
| ,, 7th | 92·06 | 63,000 | 591,600 |
| | | | 6,382,100 |

Column 9 represents the work, T″, expended in exciting the electromagnets.

*Electrical Exciting Work.*

| | Difference of Potential. | Quantity of Electricity. | Corresponding Work. |
|---|---|---|---|
| January 4th | 82·21 | 48,700 | 408,400 |
| ,, 5th | 91·08 | 72,800 | 676,300 |
| ,, 6th | 92·91 | 62,900 | 596,100 |
| ,, 7th | 92·06 | 21,600 | 202,800 |
| | | | 1,883,600 |

Column 10 gives the value of the electrical work, T‴, at the ring: it was calculated for each day by multiplying the resistance of the ring, 0·27, by the square of the total intensity at the galvanometer, and by the number of seconds.

| Resistance of the Ring. | Intensity of Current. | Number of Seconds. | Electrical Work at the Ring. |
|---|---|---|---|
| 0·27 | 13·29 | 19,800 | 94,400 |
| 0·27 | 10·78 | 25,200 | 79,100 |
| 0·27 | 10·266 | 27,000 | 76,800 |
| 0·27 | 8·54 | 9,900 | 19,500 |
| | | | 269,800 |

It is worth while to draw attention to the fact that by taking the sum of these different amounts of electrical work, and adding to it the work of transmission, measured directly, we have (to within about 2 per cent.) the work, T, taken upon the dynamometer, as is shown by the following table:—

| | |
|---|---|
| T = 9,569,798 | T′ : T = 0 666 |
| T′ = 6,382,100 | T″ : T = 0 197 |
| T″ = 1,888,600 | T‴ : T = 0 028 |
| T‴ = 269,800 | $t$ : T = 0 085 |
| $t$ = 808,750 | |
| 9,349,250 | 0 976 |

*Electromotive Force and Resistance of the Battery.*

The electromotive force of the battery is given directly by the indication of the electrometer when the circuit is open. Let E represent this value, and $e$ the indication of the electrometer, when the circuit is closed, and when the intensity of the current is I. Finally, let R be the resistance of the battery; we shall obtain $e = E \pm R I$, according to whether the battery is being charged or discharged. The values of $E_1$, $e$ and I being known, we can deduce from them that of R, which measures the sum of all the resistances.

During the charge the value of E varied from 72 to 75·8 volts, *i.e.*, from 2·057 to 2·165 for each element; that of $e$ was on an average a little under 90 volts, the mean intensity of the current being 8·55 ampères.

During the discharge the value of E was brought back from 75·6 to 72 volts; the value of $e$ was reduced to about 60 volts, with a mean intensity of 16·16 ampères.

The resistance of each element during the charge varied from 0·023 of an ohm to 0·075; during the discharge from 0·006 to 0·040; at the beginning of the discharge the change of polarity in the current made this resistance suddenly fall from 0·075 to 0·006.*

| | Electromotive force of the open Battery. | | Apparent resistance of the Battery. | |
|---|---|---|---|---|
| | Initial. | Final. | Initial. | Final. |
| January 4th | 72·00 | 75·10 | 0·80 | 1·28 |
| ,, 5th | 73·10 | 75·60 | 1·41 | 2·32 |
| ,, 6th | 72·10 | 75·50 | 2·58 | 2·61 |
| ,, 7th | 74·50 | 75·80 | 2·61 | 2·63 |

*Summary of the Process of Charging.*

The charging of the battery occupied 22 h. 45′, and was effected in four operations. Table I., which follows, gives for each day the principal results relating to this first part of the experiment.

TABLE I.—THE CHARGING OF THE BATTERY.

| Date and duration of experiment. | Mean speed of magneto-electric machine in revolutions per minute. | Mechanical work indicated by the dynamometer in kilogrammetres | Mean potential of the battery in volts. | Mean intensity of charging current in ampères. | Mean intensity of exciting current in ampères. | Quantity of electricity supplied to the battery in coulombs. | Electrical work of the charge in kilogrammetres. | Electrical work of exciting in kilogrammetres. | Electrical work of the ring in kilogrammetres |
|---|---|---|---|---|---|---|---|---|---|
| Jan. 4, 5h. 30′ | 1,079 | 2,414,907 | 82·21 | 10·93 | 2·46 | 216,400 | 1,814,600 | 408,400 | 94,400 |
| ,, 5, 7h. 00′ | 1,072 | 2,772,292 | 91·08 | 7·97 | 2·81 | 200,800 | 1,947,100 | 676,300 | 79,100 |
| ,, 6, 7h. 30′ | 1,083 | 3,246,871 | 92·91 | 7·94 | 2·83 | 214,300 | 2,028,800 | 596,100 | 76,800 |
| ,, 7, 2h. 45′ | 1,085 | 1,135,728 | 92·06 | 6·36 | 2·18 | 63,000 | 591,600 | 202,800 | 19,500 |
| 22h. 45′ | | T=9,569,798 | | | | 694,500 | T′=6,382,100 | T″=1,883,600 | T‴=269,800 |
| | | $t$= 808,750 | | | | | | | |
| | | 8,761,048 | | | | | | | |

*Time of Discharge.*

The discharge was performed in 10 h. 39′, and in two operations on the 7th and the 9th of January; it was effected, as has been mentioned above, through 11 Maxim lamps, placed in derivation. The experiment began with 30 elements only. At the end of six hours two more elements were added; about two hours after, and for a quarter of an hour only, the three remaining elements were added. The current then had an intensity higher than that required for the normal working of the lamps.

The experiment on the discharge was stopped on the first day after 7 h. 15′, and resumed two days later. At the end of 2 h. 30′ of this fresh discharge, the battery had returned to its previous condition. The experiment, however, continued, but the quantity of electricity and the corresponding work during this latter period, are not included in the table which gives the result of the observations made during the normal discharge.

*Electrical Calculations.*

The calculations relating to the electrical measurements were effected by the methods already described. Amongst others we may give that which relates to the total expenditure of electricity:—

| Dates. | Average Intensities. | Seconds. | Coulombs. |
|---|---|---|---|
| Jan. 7th | 16·128 | 26,340 | 424,800 |
| ,, 9th | 16·235 | 12,000 | 194,800 |
| | | | 619,600 |

* The resistance, R, deduced by the above-mentioned formula from the values of E, $e$ and I, obtained by observation at short intervals, is the apparent resistance of the battery. It is not impossible that a considerable portion of the variations may be due to some phenomenon of polarisation.

As regards the condition of the battery, it is characterised by the following indications :—

| Dates. | Electromotive force of the Battery of 33 elements open, in volts. | | Apparent resistance of the Battery in ohms. | |
|---|---|---|---|---|
| | Initial. | Final. | Initial. | Final. |
| Jan. 7th | 75·01 | ... | 0·21 | 0·25 |
| ,, 9th | 72·50 | 72·00 | 0·26 | 1·41 |

*Resistance of the Lamps.*

If we call $r$ the resistance of the outer circuit during the discharge, we get

$$e = \text{E} - \text{R}\,\text{I} = r\,\text{I}$$

which enables us to calculate the value of $r$, since those of $e$ and I are ascertained at every instant by observation. The circuit was closed by 11 Maxim lamps placed in derivation, and the mean resistance of these lamps was, when cold, 74 ohms.

The intensity of the current having varied from 1 to 1·65 ampères per lamp, the variation of resistance presented the same conditions of increase and decrease, as we shall show afterwards when treating of the decrease of luminous intensity.

*Photometric Measurements.*

During the entire duration of the normal discharge of the battery, it maintained in action 11 Maxim lamps, the luminous intensity of which varied from 1 to 2 carcels, the mean being 1·40; which corresponds to 10 h. 39′ × 1·40 = 13 h. 30′ of 11 carcels, or to a light of 149·1 carcels for one hour. The total electrical work developed by the battery having risen to 3,809,000 kilogrammetres, each hour carcel would have cost $\frac{3809000}{149{\cdot}1} = 28{,}820$ kilogrammetres, or 8 kilogrammetres per second. One horse-power of electrical work would be sufficient to maintain with ease the number of lamps necessary to produce a continuous light of from 9 to 10 carcels.

As soon as the light of a lamp descends to one carcel or less, the consumption per unit of luminous power goes on very rapidly and increases.

We give also some special results obtained under extreme conditions. It is not necessary to dwell upon the last, in which the lamps were so far below their normal working that we need not take them into account.

| Time of observations. | Electromotive force. Volts. | Intensity of current. Ampères. | Electrical Work | Work per lamp. | Photometric Intensity | Work per carcel. | Carcels per H.P. |
|---|---|---|---|---|---|---|---|
| 2h. 43′ | 61 | 16·37 | 101·75 | 9·25 | 1·43 | 6·47 | 11·59 |
| 12h. 45′ | 59·5 | 15·94 | 96·84 | 8·80 | 1·72 | 5 12 | 14·65 |
| 4h. 00′ | 44·9 | 11·49 | 52·62 | 4·78 | 0·21 | 22·76 | 3·29 |

*Summary of the Process of Discharging.*

The discharge was effected in two different operations on the 7th and 9th of January, and lasted altogether 10 h. 39′.

The principal points of importance in this discharge are indicated in the following table :—

TABLE II.—DISCHARGE OF THE BATTERY.

| Dates and Duration of Experiment. | Mean Potential of Battery in Volts. | Mean* Resistance of Current in ohms. | Quantity of Electricity in Coulombs. | External Electrical Work in kilogrammetres |
|---|---|---|---|---|
| Jan. 7th, 7h. 19′ | 61·39 | 16·128 | 424,800 | 2,608,000 |
| ,, 9th, 3h. 20′ | 61·68 | 16·235 | 194,800 | 1,204,000 |
| 10h. 39′ | | | 619,600 | 3,809,000 |

*Conclusions.*

The examination of the above figures offers real interest; we see in the first place that between the quantity of electricity introduced into the battery (694,500 coulombs) and that given out by it (619,600 coulombs) there is a difference of 74,900 coulombs only, corresponding to a proportional loss of about 10 per cent. (0·108).

The external electrical work, during the entire duration of the discharge, amounts to 3,809,000 kilogrammetres; the mechanical work expended had amounted to 9,570,000 kilogrammetres, but out of this work actually supplied only 6,382,000 kilogrammetres were able to be stored up by the battery. Hence it follows that the work recovered during the discharge represents :—

3,809,000 : 9,570,000 = 040 of the total work
and 3,810,000 : 6,382,000 = 060 of the work stored up.

This result is easily explained by the fact that the quantity of electricity remained to all intents the same under the two conditions with which the discharge was performed: (1), with a mean potential of

$$\frac{63380000}{695300} = 91 \text{ volts}$$

and (2), with a mean potential of

$$\frac{38090009}{619600} = 61{\cdot}5 \text{ volts.}$$

Between the two cases the levels were in the ratio of 3 to 2. This difference of potential in the two distinct operations is inevitable. In fact, if we represent by E the electromotive force of the battery, by R its internal resistance, by I and $t$ the intensity of the current and its duration during the charge, and if we represent by the same letters accented the corresponding quantities for the discharge, the electrical result is expressed by the formula :—

$$x = \frac{\text{I}'\,(\text{E}' - \text{R}'\,\text{I}')\,t'}{\text{I}\,(\text{E} - \text{R}\,\text{I})\,t}$$

Leaving out the loss of electromotive force, we get $\text{I}'\,\text{T}' = \text{I}\,\text{T}$, and we can also conclude that $\text{E} = \text{E}'$, whence we obtain

$$x = \frac{\text{E} - \text{R}'\,\text{I}'}{\text{E} + \text{R}\,\text{I}}$$

We see, therefore, that the result obtained will always be less than unity, but the smaller the intensities and resistances are the higher will this result be. It is therefore advisable to charge the battery with the weakest current possible, and consequently to prolong the duration of the charge. In the experiment in question, E being about 75 volts, it was found that R′ I′ was to all intents equal to R I, although I′ was greater than I. This was because the resistance of the battery was obviously weaker during the discharge than during the charge.

To sum up these results, and put them in a more comprehensible form, the charging of the battery required a total mechanical work of 1·558 horse-power during 22 hours 45 minutes = 1,365 minutes, or 1 horse-power during 1·558 × 1,365 minutes = 2,126 minutes, or 35 hours 26 minutes. The battery actually received only 0·66 of this work, the remainder having been employed in passive resistances, and in exciting.

The work of 6,382,100 kilogrammetres, thus stored up, was itself only converted into electrical work to the amount of 60 per cent., and there is reason to suppose that this would have been the case in any other application analogous to that of working the Maxim lamps for which it was employed. The employment of the accumulator, therefore, required 0·40 of the power supplied by the dynamo-electric machine which produced the current, or, in other words, 0·40 of the electrical work which would have been available if acting directly upon the lamps. It is only fair to add, however, that in many cases this loss would be fully counterbalanced by the advantage of having at hand and entirely at one's disposal so abundant a source of electricity. The battery also constitutes a powerful regulator, the action of which would be sufficient, at need, in certain special applications, to supply the place of the motor for a somewhat lengthened space of time.—*La Lumière Electrique, March 11th*, 1882.*

[* (*Sic*), "Mean intensity of current in ampères" is what is evidently meant.—ED. ELEC. REV.]

[* We think some of these figures given by our contemporary are incorrect, and we purpose considering the matter before our next issue.—ED. ELEC. REV.]

# CORRESPONDENCE.

## TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Correspondence should arrive not later than Tuesday morning if it is desired to appear in the following number.

## A CHEAP FORM OF VOLTAIC BATTERY.

*To the Editor of* THE ELECTRICAL REVIEW.

SIR,—I would recommend "Amateur†" to use a Swan or a small Edison lamp for the lighting, and a Griscom motor (to be had of Mr. E. Paterson, 76, Little Britain, E.C.) for the sewing-machine. Yours obediently,

Glasgow, *March 7th*, 1882. A. R. BENNETT.

[† See page 165.—ED. ELEC. REV.]

## THE INVENTION OF THE TELEPHONE.

*To the Editor of* THE ELECTRICAL REVIEW.

SIR,—Having in my letter, which was published in the ELECTRICAL REVIEW of 18th February, expressed my opinion that Morgan-Brown's patent of 9th December, 1876, was invalid in consequence of prior publication in Great Britain, I beg you to permit me to cite the decisions of eminent British judges upon which I based my opinion. The prior publication, upon which I rely, is the publication of Bell's United States patent of March 7th, 1876, in the *Official Gazette* printed and published by the United States Patent Office on the 7th March, 1876, which printed book was in file in the public library of the British Patent Office on the 3rd July, 1876, and has been there ever since, open to the public. In that publication the first claim in Morgan-Brown's patent is set out in *ipsissimis verbis* in the second claim of the United States patent. Lord Ellenborough, in Huddack *v.* Grimshaw (I. W. P. C. 86), said :—"An inventor's claim to novelty is destroyed by showing previous

publication of the invention in some printed book in use in Great Britain, or in the specifications of a former patent. If prior to his obtaining a patent, any part of that which is of the substance of the invention has been communicated to the public in the shape of a specification of any other patent he cannot claim the benefit of his invention."

In Jones *v.* Berger (I. W. P. C. 550) Maule, J., remarked, "I think it is an objection to a patent, and not evidence simply of an objection, that there has been a previous patent and specification enrolled embracing the invention. In the same way I think it is an objection to a patent that it has been published in such a book."

In (I. W. P. B. 473) Household Company *v.* Neilson—an appeal from the Court of Session of Scotland to the House of Lords—Lyndhurst, L. C., asked, "If the machine is published in a book, distinctly and clearly described—corresponding with the description in the specification of the patent—though it has never been worked, is not that an answer to the patent?" And Lord Brougham added, "It negatives being the true and first inventor."

In my previous letters I referred to the prior publication of the first claim only of Morgan-Brown's disclaimer. I beg leave now to refer to the same *Official Gazette* for a prior publication of the second and third claims, which are substantially the same as the fifth claim in Bell's United States patent of March 7th, 1876.

In regard to these claims I quote the words of Lord Ellenborough in Rex *v.* Callen (1 Stack, 354, I. W. P. C. 76). Lord Ellenborough said :—"Patentee claimed a principle which was not new; the patent was bad."

I avail myself of this opportunity to express my utter detestation of those persons who would knowingly deprive an inventor of the honour and profit due to him for his invention ; and at the same time I cannot refrain from expressing my contempt for a patentee, or his assignees, who barefacedly claim a monopoly for an invention the patent for which does not justify the monopoly, especially if the patent itself is void for want of novelty.

Yours truly,

W. C. BARNEY.

London, *March 14th*, 1882.

## PATENT SPECIFICATIONS.

*To the Editor of* THE ELECTRICAL REVIEW.

SIR,—In the above journal I have often noticed that in the list of abstracts of published specifications there is a price given after the date. Does this mean that full particulars of specifications can be had for the amount stated ? and if so, from whom ? The one I refer to in particular is on page 187 of the journal for the 11th inst., viz., "Telephonic and Telegraphic Signalling Apparatus. A. C. Brown and H. A. C. Saunders. Dated July 7. 6d."

If you can kindly give me any information *re* above, you will greatly oblige,

Manchester, ARMATURE.
*March 13th*, 1882.

[The price given is that of the complete specification, which can be obtained at the office of the Commissioner of Patents, Cursitor Street, Chancery Lane.—ED. ELEC. REV.]

## THE EDISON ELECTRIC LIGHT.

*To the Editor of* THE ELECTRICAL REVIEW.

SIR,—Knowing the impartial nature of your Journal I send you the inclosed slip for publication. It was cut out of one of the leading New York papers of about January 4th, 1882. As the Edison Company has been so careful that the British public should hear all that has been printed in their favour in New York, it is but fair and just that they should hear what else has been printed there. Hoping that this will be printed, so that an explanation can be had,

I remain,

Yours truly,

JOS. E. LOCKWOOD.

25, Avenue de l'Opéra, Paris.

"EDISON'S ELECTRIC LIGHT.

"A Failure—Discharge of the Employés.—The Edison Electric Light Company, after having been actively employed in placing wires in buildings in the lower part of the city for ten months past, to-day suspended operations for the present, and no further steps will be taken to introduce the light on the district system for some time. Over one hundred men were employed by this company during the summer, but this number has been reduced until only thirty men were on the roll. The superintendent to-day notified these that their services were no longer required. The Edison Machine Works and the Edison Electric Pipe Company have also made large reductions in their force, and only those absolutely necessary to keep these works in operation have been retained. This suspension causes an indefinite postponement of the illumination of the first district by Edison's light, and it is impossible, even if work is resumed in the early spring, for the light to be in operation before next winter."

[We publish the above in accordance with our usual custom, which is as far as possible to put before our readers all correspondence which may be of interest. At the same time we must confess that in this cutting from the American papers we perceive nothing to affect our appreciation of the value of the system, for the suspension of operations might be occasioned simply by a hitch in financial or other arrangements. We do not anticipate a like result with the Edison Company now operating in England, for their management is all that can be desired.—ED. ELEC. REV.]

## THE ACTION OF THE TELEPHONE.

*To the Editor of* THE ELECTRICAL REVIEW.

SIR,—Again referring to the question whether the telephone receiver can work by a make-and-break current, I point out that the telephone receiver will act with the secondary current of an induction coil. Now it is impossible for any one to allege that the secondary current from an induction coil is in any way analogous in its nature to what Bell describes as an undulatory current; and unless all our previous investigators have been altogether in the wrong as to the action of the induction coil, the current generated in the secondary is instantaneous only, whatever may be the direction in which it may flow.

This question of whether the telephone, when reproducing human speech, works by an undulatory current as described by Bell, or whether it can and does work by a make-and-break current, is admitted by "the most eminent electrician in the United Kingdom" to be the pith of Bell's claim to be regarded as the inventor of the articulating telephone. It will be remembered that Bell was not the only person working at the telephone. Amongst others, Elisha Gray in America was carefully carrying on a series of experiments, aided by ingeniously designed apparatus, some of which apparatus is capable of reproducing some of the sounds of human speech, though not very distinctly ; and it is plainly stated in Prescott's book on the telephone that it was not until Bell used Elisha Gray's transmitter that he was able to do anything in the way of reproducing articulate speech, and that it was by using Elisha Gray's transmitter with his (Bell's) receiver, a copy of which was exhibited and described by Sir William Thomson at Glasgow, that articulate speech was reproduced. Sir William Thomson also described the Bell telephone in his official report on the Philadelphia Exhibition, and the singularly remarkable inconsistency between Sir William Thomson's evidence at the recent trial and that report has already been pointed out in your columns.

Sir William Thomson stated in his evidence that he could not make the receiver that Bell had given him speak, and that an inspection of that receiver, even aided by the information given by Sir William Thomson at Glasgow, would not enable a workman of ordinary skill to make the Bell telephone. This statement I absolutely deny. Only a few minutes' inspection of that receiver would enable any one who had any experience of electrical apparatus to make a *facsimile* instrument ; and whether that instrument would speak or not would depend solely on the transmitter, and on the distance at which the metal plate or diaphragm was kept from the pole of the magnet. In this instrument there was nothing specially new ; the electro-magnet itself was a very old and well-known form, frequently of late called the "Altandi" magnet, and the only thing that was added by Bell was the metal plate or diaphragm. And until it is decided to the contrary by a competent tribunal in this country, it may properly be considered that every one has a right to combine a metal diaphragm with an electro-magnet, and to obtain from such combination all the results that it

is capable of producing. The whole secret of that instrument lay in placing the metal diaphragm at a small distance only from the pole of the magnet; but this secret was not at that time known either to Bell or Sir William Thomson, though the effect of the position of the plate was known and was mentioned by Sir William Thomson in his official report. It is not necessary that the plate should be fastened down in any way—indeed, many telephones will speak best when the plate is quite loose; all that is required is some arrangement to prevent the plate actually touching the pole of the magnet or approaching within some particular, though very small, distance of such pole. If you take the receiver exhibited by Sir William Thomson at Glasgow, put it in circuit with a good articulating transmitter, and then press the plate against the ear, you will soon find that there is one position in which that receiver will speak, though not well, on account of the faulty arrangement of the magnet. Sir William Thomson could not make the receiver speak, first, because he had not a good articulating transmitter; second, because, he says, he did not know how to use the receiver. But it would hardly be contended that if Bell had given Sir William Thomson a new form of gun, which Sir William Thomson had publicly exhibited, described, and left open for public inspection, such gun might afterwards have been patented by Bell on the ground that Sir William Thomson was a bad shot: yet this is the substance of the argument used by the complainers in support of their patent.

I state that the plate need not be held down, that is, for any electrical or acoustic reason. It is convenient to fasten it down, but that is only to prevent it from moving, or falling off when the instrument is moved. I say further that there is no virtue in supporting the plate all round its circumference; it is sufficient if it is supported at two or three places, so as to keep it at the proper distance from the pole of the magnet; nor is there any advantage, though there may be a convenience, in a circular plate. I have used them indifferently, round, oval, oblong, square, triangular, and many other shapes. Indeed, I often take up and use any odd piece of thin iron that may happen to come to hand; and in the little electro-magnet receiver, a description of which I inclosed in my last, the triangular form with the points of the triangles taken off is the most convenient.

The action of the diaphragm in the receiver is not, I think, fully understood by any one, but the results of my experiments indicate that it acts only as a tympanum; that it is set in motion by the attractive power of the magnet, and that the portion of the diaphragm of an ordinary telephone that is actually in use in the reproduction of sound is exceedingly small, and not more than one-half to three-quarters of an inch in diameter. It is not necessary to go to Bell's receiver for an instrument capable of reproducing speech. Elisha Gray's harmonic telephone, made, according to Prescott, some years before Bell's telephone, will, with a good transmitter, reproduce speech, though not very distinctly. It appears that all that is required is that the whole of the disc or plate used as an armature shall not be free to vibrate and produce its natural musical note. I am strongly disposed to think that Bell, when experimenting with some of the telephonic apparatus designed by Elisha Gray and others, noticed that under some special circumstances some of the sounds of the human voice were reproduced; and indeed it is difficult to make a telephone receiver that, with a good transmitter, will not respond to some of the tones of the human voice.

For the successful transmission and reproduction of speech two things are required, a good transmitter and a good receiver. It is admitted that Bell did not design a good transmitter, and all the necessary particulars of his electro-magnet receiver were (Sir William Thomson and Sir F. Bramwell to the contrary notwithstanding) made public by Sir William Thomson in his address at Glasgow, and in his official report on the Philadelphia Exhibition. The permanent magnet telephone is in a slightly different position, and Morgan-Brown says in his disclaimer that he confines "the claims in the said specification to arrangements of telephonic apparatus, wherein are employed plate armatures, or armatures other than those carried by a membrane, and arrangements wherein are employed permanent magnets, or magnets excited by batteries which are not in the main circuit or line wire."

In the foregoing remarks and in my former letter I have endeavoured to put forward two propositions, first, that the telephone receiver will work with make-and-break currents, or currents that are not such as described by Bell as undulatory currents, and with such currents will reproduce sounds having both a larger and a smaller number of vibrations per second than are to be found in the human voice; second, that the telephone given by Bell to Sir William Thomson, and exhibited and described by him at Glasgow, described also in several of the scientific periodicals and in Sir William Thomson's official report, prior to the application of Morgan-Brown for his patent, conveys all the information that is necessary for the construction of an efficient telephone receiver. I have made, and could make again, an electro-magnet telephone receiver in which the plate was a piece of an old cocoa-tin bent round the magnet, and adjusted merely by the pressure against the ear, yet this instrument spoke fairly well. I could easily carry on a conversation with it, and have done so.

It must not be forgotten throughout the consideration of this subject that Bell's original alleged discovery was of what he called an undulatory current of electricity, and that he bases the description of his instruments and his explanation of their mode of action solely on this theory. Now, I doubt very much whether there is, or can be, an undulatory current of electricity as described by Bell, but if there is such a thing, it certainly was not discovered or invented by Bell. Cromwell Varley, many years ago, used a current of varying intensity or quantity, to which I believe he applied the term "undulatory current." The idea of an undulatory current is that of a current passing continually without ceasing, but varying in quantity or power. This appears to me to suppose that the electric current is very slow in its action, and that it is, whatever it may be, compressible in its nature; and it suggests itself that if the telephone works by what is described as an undulatory current, it would work better on long lines than on short ones, as owing to the enormous speed with which electricity travels—over 288,000 miles a second—it would be hardly possible to get two undulations at the same time on a short wire. If, on the other hand, the telephone works by make-and-break, as other telegraph apparatus does, it would tend to lose its distinctness of articulation as the length of the line-wire increased, and this, we know, is actually the case.

In connection with many of these electrical matters people do not always remember the distinction between a discovery and an invention. A man may make a most important discovery, but a discovery is not the subject of a patent, though the invention of the apparatus by which a discovery may be brought into use may be the subject of a patent; and if it was discovered by Bell that currents or waves, whichever they may be, could be made to traverse a wire so rapidly that the human voice could be reproduced, and it may be a very important and clever discovery, but that however is a discovery of one of the laws of nature, and cannot be monopolised by any one person. This fact was, moreover, discovered and made known, in its leading features, long before Bell appeared on the scene; that is to say, it was well known that musical notes, many of them of a very high pitch, could be reproduced by electricity. But the human voice as naturally used in speaking is not composed of musical notes or tones, as is shown by the fact that people have to be taught to sing, that is, taught to make the voice produce musical notes; and the power of producing such musical notes by the human voice, that is, of singing, is frequently only acquired after years of practice. Therefore it would appear that an armature, or a series of armatures, that would reproduce the notes of music only, would not reproduce the sounds of the human voice. Again, any freely vibrating armature will whilst vibrating freely make only a certain number of vibrations per second, depending chiefly upon its length and thickness. To make it produce other sounds its freedom of vibration must be checked by some mechanical means, or by some power or force equivalent to a mechanical power or force. In the case of the telephone we have an armature that is not free to vibrate and produce its natural musical note. The vibrations, and consequently the sound resulting from such vibrations, are created and restrained by the magnet, and however rapidly the attractive force of such magnet may be made to vary, the vibrations of the armature correspond; whilst if the armature is not under some restraint, but is free to set up its natural vibrations, it

will overcome the power of the magnet, and its vibrations will not correspond with the rapidly changing magnetism of the magnet. This restraining power of the magnet extends only to a very short distance from the pole, and herein lies the secret of the telephone receiver.

I believe that all the vibrations which produce or constitute sound may be resolved into the two elements only—length and breadth or height—whatever other scientific terms may be applied to those elements. The vibrations of a telephone plate, as of everything else, occupy some time, however short that time may be, and the vibrating plate moves through some space, however small that space may be; so that if the plate is moving through a space which corresponds to a rate of vibration of 500 per second, and the transmitter sends a current of 1,000 vibrations per second, the movement of the plate is at once checked, and it has to assimilate its movement to the 1,000 vibrations per second, and so on with any other rate of vibrations. You thus obtain all the effects claimed for an undulatory current, and if my reasoning is correct, as I believe it to be, you obtain, by what Bell in his patent terms a direct intermittent or a direct pulsatory current, all the effects which, it is alleged, can be obtained only from what Bell terms an undulatory current; and it follows that Sir William Thomson's expressed opinion that "these articulate sounds (speech) can only be made by continuous currents" is altogether incorrect.

In my next I propose to give my reasons for believing that the hard carbon microphone works by make-and-break, and that an instrument of the nature of a microphone so working had not occurred to Edison at the time of his application for a patent.

I am, Sir, your obedient servant,

Pump Court, Temple, E.C. H. B. S. STRANGWAYS.
*March 14th*, 1882.

## PROCEEDINGS OF SOCIETIES.

### PHYSICAL SOCIETY.—March 11th

Professor Fuller in the chair.

New Member—Mr. D. Reece Jones.

Mr. Newth showed some experiments illustrative of the fact announced by M. Mascart in 1875, that solid particles in the air are necessary to the formation of fogs; and secondly, that certain gases, such as sulphurous acid gas, also cause fogs in the same way, by permitting the moisture to condense upon their particles. The experiments consisted in passing an electric light beam through large bulbs of glass containing air and a small quantity of water. When the air in the bulbs was washed with the water, and thus freed from motes, the fog produced in the bulb by slightly exhausting it with an air-pump was much less than when the air of the room, or smoke, or sulphurous acid gas was admitted into the bulb. The dust on a platinum wire, rendered incandescent within the globe by an electric current, also caused a sensible fog. It follows that with gas fires, instead of coal, there would still be fogs, though not so black ones.

Professor F. Guthrie, F.R.S., read a paper on "The Discharge of Electricity by Heat." This was concerned with additional experiments to those made by the author on the subject nine years ago. He showed by means of a gold leaf electroscope that a red-hot iron ball when highly heated would neither discharge the positive prime conductor of a glass electrical machine nor the negative one, but on cooling the ball a temperature was found at which the ball discharged the negative conductor, but not the positive one. Lastly, on cooling the ball still further (but not below a glowing temperature), it was found to discharge both positive and negative electricity. A platinum wire rendered red-hot by the current also discharged a negatively charged electroscope more readily than a positively charged one. When placed between two electroscopes, one having a + and the other a — charge, it discharged neither. When the + one was withdrawn the — was discharged, but when the — was withdrawn the + was not discharged. There therefore seemed a tendency in a hot body to throw out + rather than — electricity. That a material medium between the heated body and the electrified one was necessary was shown by the failure of the experiment with a Maxim incandescent lamp consisting of a carbon filament in a vacuous bulb. Dr. Guthrie also showed the demagnetisation of a small magnet in the heat of a Bunsen flame by inserting it in a coil of wire connected to a mirror galvanometer, and heating it in the flame. He also showed that the pole of a voltaic battery could be discharged by heating it red-hot. This was done by connecting a piece of fine platinum wire to one pole and heating it in the flame of a spirit lamp, care being taken to insulate the lamp to prevent its conduction to earth. The discharge was shown by means of a mirror electrometer.

### THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

An ordinary general meeting of this society was held on Thursday, March 9th. Lieut.-Col. Webber, R.E., President, in the chair. The minutes of the last meeting having been read and confirmed, and the list of new and proposed members read, a paper was read by Mr. W. H. Stone, M.A., F.R.C.P., Member, and Mr. W. J. Kilner, B.A., M.B., on "Measurements in the Medical Application of Electricity."

Mr. W. H. Stone (who read the paper) commenced by saying that the paper had been suggested by the chairman. The details he was about to give in his were only preliminary to the general subject, and he hoped at a future time to deal more fully with the same.

Medical electricity had hitherto been dealt with in a very loose and unsatisfactory manner, and all the facts that had been obtained were disputed, and a great many of the conclusions and statements were utterly false. The author referred to a letter published on page 164 of The Electrical Review as an instance of the absurdity of some of the statements which were made. He also referred to a pamphlet which he had before him, in which equally absurd observations and conclusions appeared. He instanced a case in which it was said that a horse or cow could be cured by electrical methods for a fee of 5s., a human being for 2s. 6d., and a sheep for 1s.

To put the whole matter in a proper light was a very difficult matter, considering the false and misleading way in which the entire subject had been hitherto dealt with.

"Measurement" was the sole subject of the paper. The connection between electricity and nerve force he did not intend to deal with, but he would remark that this question had never yet been thoroughly considered. The science of medical electricity had suffered considerably from its having been dealt with solely by physiologists and physicians; the physicist should take the matter in hand, since, to some extent, the effects of electricity required to be treated mathematically, and it was rarely that any other than the physicist could deal with the question in that way; general results alone were not sufficient.

The subject of medical electricity had been taken up at the late Congress in Paris, though but little resulted from it.

In employing electricity for medical purposes four different methods had been tried, viz.: 1st, continuous currents; 2nd, intermittent continuous currents; 3rd, induced currents; and 4th, statical electricity. The last of these, viz., "statical electricity," was the first ever employed, but it had given the least satisfactory results—in fact, the results obtained by its use were practically valueless. The third method, *i.e.*, induced currents, has been greatly used, chiefly because it had been very strongly advocated by Duchesne. This gentleman had pointed out how a great number of diagnoses of disease could be made by means of induced currents; this, however, represented only one side of the question. To test the action of electricity on the nerves and its effect as a stimulant, did not touch the therapeutic side of the question. Both kinds of current are good in cases of paralysis, but the continuous current appears to be the best, and it has therefore been the most employed recently. Intermittent continuous currents are very efficacious, and are finding favour.

In order that results may be comparable it is absolutely necessary that measurements be made. First, as regards "resistance." The resistance of the human body is very high, the resistance of the trunk being as much as 6,000 ohms; from the nape of the neck to the top of the spine the resistance averaged about 1,500 ohms; from the head to the nape of the neck the resistance averaged about 1,930 ohms, the skin in all cases being wetted. The resistance of tissue was comparatively low; calling it 1, the resistance of cartilage would be 2, and tendons and nerves rather more; bone was as much as 19; the resistance of the skin varies according to its state. Personal peculiarities also modify the resistances. A delicate skin has less resistance than a hard and dry one; the skin of the face and neck have the least resistance, and that of the palms of the hand the most. Disease changes the resistance; lead paralysis, for example, increases it; when atrophy takes place resistance decreases. Measurements of a sound and a paralysed leg on a person showed resistances of 3,482 and 3,127 ohms respectively.

As regards the question of "current," the results were somewhat discordant with reference to what was a "safe" current; 50 milliampères might be called an unusually strong current, and 20 milliampères a safe current. The effect of a current in curing diabetes was unmistakable.

The form of battery to be used in producing the current was quite immaterial, the bichromate or sulphate of mercury were both convenient. Great stress has been given to the necessity of the batteries having weak chemical action and great constancy; the latter is of course desirable, but the former is not at all necessary, as the current strength can always be reduced by introducing resistance into the current. For measuring the current an ordinary galvanometer will answer the purpose, but the authors have devised a convenient form of testing apparatus, which includes a portable Thomson galvanometer, with shunts, &c.

The size of the poles for applying the current to the body should be as great as possible, so as to make their resistance as low as possible. Amalgamated zinc, wetted with sulphate of zinc solution, has been recommended for the poles, but the authors prefer powdered carbon, inclosed in a bag and backed by a metal plate; the poles can hardly be too large.

The author then described a simple apparatus for producing intermissions in the current at any required intervals of time. This apparatus simply consisted of a metronome with contact pieces fitted to it, which dipped into mercury cups at each oscillation; a condenser was fixed underneath the instrument to get rid of the extra current; this makes the shocks more bearable and satisfactory in their effect.

The measurement of induced currents presented considerable difficulties. The Conference at Paris had recommended the use of standard induction coils, but this does not give means of measurements. The author had tried as a shunt to an induction coil a vacuum tube, the tension of the air in which could be regulated at pleasure; this gave a ready means of regulating the power of the discharge. The author had recently adopted, instead of induction coils, condensers of definite capacities charged to definite potentials, this gave a ready means of regulating the power. For condensers, he found ebonite plates, coated with tinfoil and plunged into paraffin oil, to answer very well.

Dr. KILNER then described the portable galvanometer which he had invented. This galvanometer enabled currents from 25 milliampères to 30,000 to be measured and indicated. He had found a water regulator, with a sulphate of copper solution, very handy. The method of measuring resistances was that of adding a known resistance in the circuit, and then noting how much the galvanometer deflection had become reduced.

In the discussion which followed the reading of the paper, Mr. PREECE said that when the stage was arrived at at which quantitative measurements were employed a very great advance had been made; it was the same in the case of telegraphy. He pointed out that as early as 1759 John Wesley had advocated the use of electricity for curative purposes. With regard to the measurement of induced currents, which necessarily alternated, he would recommend the electro-dynamometer being tried, as this instrument gave indications in the same direction with all currents.

Dr. COFFIN said that instrument makers should be careful in making electrical apparatus to see that all exposed parts are properly insulated, so that accidental shocks on the part of the operator may be avoided. He said that he had devised a convenient form of pole, in which a reel of wire was placed, which was wound up by a spring, so that the loose wire, which in the ordinary arrangement intervened between the electrical apparatus and the pole, was avoided, as the wire was always kept taut by the spring reel. He pointed out the great advantage of operating on a patient in a bath, as the water between the poles acted as a shunt, whose effect could be changed at will by altering the distance between the poles.

After some remarks by Professor MACLEOD, Dr. MARKER, Mr. GRAY, Mr. FITZGERALD, Mr. GRANVILLE, Mr. SPAGNOLETTI, Mr. PULVERMACHER, and Professor AYRTON, the meeting adjourned.

## NOTES.

ON THE WHEATSTONE BRIDGE.—K. F. Slotte.—The length of the platinum wire belonging to this apparatus, which cannot be accurately ascertained for direct measurement can, as is known, be indirectly determined by comparing and changing the resistance. The following process is a modification of this method, and may be found advantageous:—

Let $s$ be the length of the wire, $a$ and $b$ that of its two divisions, when two resistances, $w_1$ and $w_2$ are intercalated and the galvanometer indicates no current. Then—

$$(1) \qquad \frac{w_1}{w_2} = \frac{a}{b} = \frac{s + a - b}{s - (a - b)} = \frac{s + d_1}{s - d_1}$$

$a - b$ being $= d_1$. If we exchange the resistances $w_1$ and $w_2$, and if the movable contact is displaced until again no current passes through the wire of the galvanometer, this displacement taken as positive or negative according as $a$ is greater or smaller than $b = d_1$, which magnitude can be directly determined by reading off the measuring-rod of the apparatus.

If in the same manner $w_2$ is compared with a third resistance $w_3$, and $w_3$ again with $w_1$, and if the displacements corresponding to $d_1$ are designated $d_2$ and $d_3$, we have—

$$(2) \qquad \frac{w_2}{w_3} = \frac{s + d_2}{s - d_2}$$

$$(3) \qquad \frac{w_3}{w_1} = \frac{s + d_3}{s - d_3}$$

From (1), (2), and (3) we obtain—

$$1 = \frac{(s + d_1)\ (s + d_2)\ (s + d_3)}{(s - d_1)\ (s - d_2)\ (s - d_3)}$$

and on resolving the last equation—

$$(4) \qquad s = \sqrt{-\frac{d_1\ d_2\ d_3}{d_1 + d_2 + d_3}}$$

These determinations executed on this method in which $w_2$ was taken approximately $= \sqrt{w_1\, w_3}$, gave for $s$ the values 1118·11, 1118·75, 118·6 millimetres.—*Wiedemann's Annalen der Physik und Chemie.*

ON THE INFLUENCE OF MECHANICAL HARDNESS UPON THE MAGNETIC PROPERTIES OF STEEL AND IRON.—By L. M. Cheesman.—The author remarks that iron and steel hardened mechanically have never been submitted to a thorough examination as regards their magnetic properties, though the fact that such hardness exerts an influence upon the magnetic condition is fully known. As the result of numerous experiments detailed in the author's memoir, it is concluded that iron in a mechanically hard condition can take up more permanent magnetism than in a soft condition; on the other hand, the magnetic momentum of a steel magnet in a mechanically hard condition is greater or smaller than in a soft condition, according as the axial relation is smaller or larger than a certain transition value. If the curves corresponding to temporary magnetism, both of iron and of steel, are compared with each other, it appears that soft wires for the same value of the separative force possess a greater momentum than hard wires;

mechanical hardness, as might be expected, offering a resistance to the rotation of the molecules. From the curves of the permanent specific magnetism of iron, it is to be concluded that the momentum of a hard iron magnet is less than that of a soft one only when the above value is very small. In rods of steel with a great axial ratio the specific magnetism both of weak and strong forces is greater in the case of soft than of hard qualities. For rods of a small axial ratio the harder has the advantage, except the forces are very feeble. These results agree perfectly with the behaviour of rods hardened by heat, as observed by Ruths and others. As regards the differences between mechanical hardening and that effected by heat, notwithstanding certain points of resemblance, there are many differences. The two conditions seem to be quite distinct, as is most clearly seen in relation to the resistance to the conduction of electricity. The specific conduction-resistance of drawn iron and steel wires has been stated very differently by different experimentalists, some alleging an increase with hardness, and others a decrease. There is, however, little change. On the other hand, according to the statements of Barns, the specific conduction-resistance of steel is altered almost threefold. The variations in the magnetic relations are by no means always in accord with this great difference. A comparison of the specific gravity of wires hardened in both methods with the corresponding magnetic moment leads to the same result. The magnetism of a rod with a small axial proportion and hardened by hammering increases with the specific gravity. The confirmation of the dependence of the specific magnetism of steel on the axial ratio (announced by Ruths) as holding good also for wires hardened mechanically, shows the importance of this point for the magnetic condition.—*Wiedemann's Annalen der Physik und Chemie.*

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ON ELECTRIC SHADOWS.—By P. Riess.—Signor A. Righi, of Bologna, has published an essay on this subject. He has not observed the luminosity of an electrified surface when an electric current of air falls upon it, but merely the dust-figures formed by this air-current. He has thus failed to recognise the important discovery made by Holtz that a narrow body placed in the air-current throws a shadow upon the luminous surface when such body is a conductor of electricity. Hence it must be concluded that a part of the air-current is discharged by an intervening conductor, whilst by a non-conductor it is merely driven out of its position. As in the latter case the entire air-current remains electric its diverted portion will be drawn back by the non-diverted portion to its former position, and impinge upon the luminous surface at the same place as if the intermediate body were absent. A slender cross of vulcanite projects a shadow upon the luminous plane only if breathed upon. This beautiful experiment shows in the simplest manner that an electrified surface in the free air is luminous only in parts where it comes in contact with an air-current charged with the opposite electricity.—*Wiedemann's Annalen der Physik und Chemie.*

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ON THE HEATING OF THE ELECTRODES BY THE INDUCTION SPARK.—By A. Naccari.—Hollow metal balls of 5 centimetres in diameter, fitted above with cylindrical appendages 1·5 centimetre in width, were then placed on a sledge with movable glass feet, and were each filled with 50 cubic centimetres of petroleum, into which was plunged a thermometer graduated to the 50th of a degree. One ball was connected with one end of the secondary wire of an induction coil, which gives sparks 48 centimetres in length; the other was connected with the other end of the coil. The result was that the negative electrode was heated more strongly than the positive. If the distance of the electrodes does not approximate to the limit at which sparks no longer pass over, the heating of each electrode is proportional to the intensity. The nature of the metals of the electrodes has no perceptible influence upon the heating. If the distance between the electrodes increases whilst the strength of the current remains the same, the heating of each of the two electrodes seems to increase to a maximum, and then to diminish. The quantities of heat developed at the electrodes are relatively very considerable.—*Wiedemann's Beiblätter.*

ON THE VOLTAIC ARC.—By N. Slonguinoff.—It is well known that the formation of the luminous voltaic arc is attended by a polarisation the value of which amounts to 12 Bunsens or 22 Daniells. Hence, according to the formula,

$$W_p = \frac{P}{D} W_d$$

(see Wiedemann's "Galvanism," 2, p. 491) there must be an absorption of heat to the extent of 528 calories. What becomes of this consumed energy? We cannot think that it is solely and entirely utilised in the destruction of the electrodes. For on the one hand the loss of matter of the electrodes is only a small part of the equivalent (Herwig); on the other hand, according to Berthelot ("Mécanique Chimique," 2, p. 334), on the conversion of 12 grammes carbon into vapour the heat rendered latent is comparable with 42·4 calories. We must, therefore, conclude that the greater part of the energy consumed appears in the arc itself as accessory heat. At first, the energy of the current is converted into a kind of mechanical energy; the particles are propelled from the electrodes; they encounter resistance (friction against the surrounding medium) and their energy is converted into heat.—*Wiedemann's Beiblätter.*

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SOME OBSERVATIONS ON GEISSLER'S AND CROOKES' TUBES.—By J. Psenicka.—Whilst the Geissler tubes on the transit of the electric current show positive tension at one end and negative at the other, it has been found in strongly exhausted tubes, the sides of which are phosphorescent, that they are positive on the whole surface. In some cases the author, especially when using the Holtz machine as a source of electricity, has observed that Crookes' tubes show negative tension on the surface. At the same time the phosphorescence of the glass was faint. After the introduction of a stratum of air the sides began to phosphoresce more strongly, and the tension at the surface became again positive. If the tube was taken in the hand, and at the same time an electrode was touched, such a quantity of electricity accumulated that the tube behaved like a Leyden jar. In Geissler tubes the discharging-strokes were equal at both electrodes, but in Crookes' tubes they were much stronger on touching the cathode. If the tubes were surrounded with tinfoil, which was in connection with one conductor of a Holtz machine, whilst the other conductor was connected with one of the electrodes of the tube, the phenomena of the charge in a Geissler tube were the same with whichever conductor the interior of the tube was connected. In a Crookes' tube the phenomena were different. Hence the author infers that highly-rarefied gas behaves like a good conductor. The strikingly different phenomena in Crookes' tubes, according as the charge is positive or negative, and especially the much stronger sparks in the former case, seem to confirm the view of Ruehlmann and Wiedemann, that the positive discharge requires a higher potential than the negative.—*Wiedemann's Beiblätter.*

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ELECTRIC LIGHTING BY INCANDESCENCE. — Messrs. Phillips Bros., of Homerton, the well-known wire coverers, have for some weeks past illuminated their offices, workshops, &c., by means of 130 Edison lamps worked from a Bürgin machine capable of producing three arc lights. This installation has been applied in a thorough manner, gas being entirely abolished, and we hear that the result has been of a most satisfactory character.

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ELECTRIC LIGHT IN FACTORIES.—Messrs. Johnson and Phillips, of Charlton, are preparing and fitting up a special electric light station, for the purpose of lighting their factory, the intention being to employ both the arc and incandescence systems. Every appliance necessary for measuring both the mechanical and electrical work will be supplied, and observations of great value and reliability may probably be looked for.

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CRYSTAL PALACE ELECTRICAL EXHIBITION.—One of the most charming exhibits to be seen at the Crystal Palace, and just at the back of the Edison salon, is the room fitted up by Messrs. Elkington and Co., the well-known electro-platers, with their artistic productions in the precious and

other metals. These beautiful *objets d'art* are produced either entirely by the agency of electricity, or plated with gold or silver by means of their patent electro processes; and anticipating the time when the electric light will be used for domestic lighting, they have designed and show in their display centre-pieces, candelabra, lamps, chandeliers, and sconces, lighted with the incandescent electric lamps of Messrs. Swan, as many as fifty lights being employed in the most artistic manner. Adjoining this room, Messrs. Elkington and Co. have arranged a stand, where the various processes of which they were the original patentees may be seen in actual working. We may add that the plating machines employed by this firm are solely those of Mr. Wilde, and the systems by which moulds are taken from valuable works of art, and reproductions made in gold, silver, or bronze, or by which articles manufactured in the inferior metals are quickly coated with gold or silver, are here practically shown and explained by experienced assistants.

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ELECTRICITY.—Some idea of the extraordinary activity at present existing in the development of electrical science, and the practical application of electricity to various useful and industrial purposes, may be gathered from the following statistics, compiled by Messrs. J. K. Fahie & Son, of the Patent Offices, High Holborn, London, and Nassau Street, Dublin :—During the year 1881 it appears that no less than 237 applications for British patents were recorded in Her Majesty's Patent Office for inventions which may be classed under the heading of *Electricity*. Of this grand total 135 emanate from British applicants, 52 from American citizens, and 50 from residents on the continent (France, Germany, Belgium, &c.). Classifying the total number of 237 applications under special heads, it appears that 93 specifications have been lodged for improvements in electric arc lamps, 20 for improvements in electric incandescent lamps, 38 for magneto and dynamo machines, 32 for secondary batteries, 26 for regulating, controlling, and measuring the electric current, 24 for miscellaneous appliances connected with electric lighting, and 4 for producing power and transmitting motion. Reviewing the names of the applicants for the above patents, it appears that the celebrated American inventor Edison stands highest on the list, having applied for no less than 24 patents for various electrical improvements; Messrs. Swan and Lane-Fox each filed 7 applications, mostly in connection with incandescent lighting, and M. Faure, of Paris, 3 for secondary batteries, while Mr. Maxim filed 2 and Mr. Brush 1 for arc lighting apparatus. The above figures show what an astonishing amount of energy is now being brought to bear on the introduction of this wonderful science, and it will certainly not be the fault of inventors if electricity be not speedily reduced to a practicable success, and made to serve in the immediate future purposes and ends of which we have little conception to-day.

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THE HEISLER ELECTRIC LIGHT COMPANY.—The Heisler Electric Light Company have established headquarters for the United States at Washington, D.C., and opened their books to supply light to individuals. They design using the Heisler dynamos and lights, both American patents, the generator being of the ring-armature type, supplying currents to lights of the arc pattern, on independent circuits.

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THE EDISON LIGHT.—The Government Printing Office, Washington, D.C., has introduced the Edison incandescent light, and it gives eminent satisfaction.

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PRIZE DESIGN FOR ELECTRICAL LABORATORY.—We have decided to award the prize to the author of the set of drawings marked with the distinguishing motto, "Electron," and dating from New Charlton (not "Electron" dating from Rotherham). The designs of the unsuccessful competitors will be ready for delivery, to those who prefer calling for them, on or after Wednesday next. Those coming from a distance will be forwarded in due course.

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ELECTRIC LIGHT FOR THE NEW LAW COURTS.—It is proposed to light the New Law Courts by means of incandescent electric lamps as an experiment.

GAS *v.* ELECTRICITY.—On the Tuesday and Wednesday evenings of February 28th and March 1st, Mr. T. P. Barkas, F.G.S., delivered two lectures on "The Present Position of Gas and Electricity as Illuminating Agents," in the Central Exchange Art Gallery, Newcastle-on-Tyne. Gas-fittings, from the ordinary batswing to Siemens' regenerative gas-burner, were shown by the Newcastle and Gateshead Gas Company; electric lamps (arc and incandescent) were exhibited by the Swan Electric Light Company. On the first evening the lecturer devoted his observations to gas only, treating on the phenomena of combustion, the heating and lighting properties of English and Scottish coal gas, and tracing the progress of street gas-lighting in London and the provinces. His concluding remarks went to show that gas as now manufactured is much improved in quality, reduced in price (the gas in Newcastle being supplied at 1s. 10½d. per 1,000 cubic feet), and is more than ever used for heating and lighting purposes. The chief advantage of gas was its cheapness and the ease with which it may be used by reason of its endless divisibility. The second lecture was on electric lighting exclusively. Mr. Barkas made a few preliminary remarks on electricity, and traced its progress from Thales, through Gilbert, Galvani, Davy, Franklin, Faraday, Wheatstone, Ruhmkorff, Siemens, Varley, Gramme, Brush, Edison, Swan, &c. He explained in a popular manner the various methods of producing currents as now used for electric lighting. Experiments were made with iridio-platinum, and the well-known lamps of Lane-Fox, British Electric Light, Edison, and Swan. The machine used was constructed in such a manner as to be most effective for the Swan lamps, a more intense current being requisite to do justice to the remaining systems. The lecturer dealt with many other interesting facts connected with his subject, and concluded that the ultimate success of the electric light was a question of economy, and pointed out that the Swan lamps were now reduced in price to 5s. each.

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UNSCIENTIFIC ELECTRIC LIGHTING.—We drew attention in our issue of the 14th January to the incompetency of many of the so-called electric light engineers in erecting installations of the new illuminating agent. As an instance of this it has lately come before our notice that a well-known ship which had been fitted up with a system of incandescent lamps has been set on fire to a slight degree by the electric current in three different places. The sub-wires conveying the current for these lamps were only cotton covered, and in many instances joints in the wires were made in the same fashion as we see in bell-wires, merely hooked together. The ship is now having properly insulated wires laid down. If the electric light can make progress under such conditions as these, how much greater will be its development when we have properly trained and skilful electricians to superintend the necessary operations.

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ELECTRICITY ON FRENCH RAILWAYS.—The Eastern Railway Company has just made a new essay in the application of electricity. A train equipped with the most recent and improved electrical apparatus proceeded from Paris to Gretz. The carriages were connected by electric communications, the brakes acted by electricity, and all the compartments of the thirteen carriages composing the train were lighted by electric lamps. The results of the experiments were completely satisfactory.

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HENLEY'S PATENT OZOKERITED INDIA-RUBBER CORE.—The engineer and electrician of the Persian Gulf Telegraphs, Mr. Henry C. Mance, in a letter to the deputy-director, and dated Karachi, 19th January, 1882, says :—"On the subject of the experimental ozokerit india-rubber core, I have the honour to inform you that subsequent tests taken at a temperature of 71° (with the testing-room carefully warmed), and calculated from the loss of charge after five minutes' insulation, gave results of over 7,000 megohms per knot for each piece, and, considering that no particular care has been taken of these pieces of core during the last two years, the trial is so far satisfactory. I have now placed one half the coil in water, suspended one quarter in the verandah, and buried the remaining quarter in sand, which will be occasionally wetted. I have also placed a small piece where it will

be occasionally exposed to the sun for the next few months. The ozokerit joints with the ends trimmed were found by me to be practically infinite." We are glad to find that this core has tested so satisfactorily, as it endorses our own experience, and it will be highly interesting to know the results of Mr. Mance's further tests under the severe conditions to which he is now exposing the material.

NOVEL ELECTRIC GENERATOR.—During last year, Mr. Charles E. Ball, of Philadelphia, a prominent inventor, devised and patented a novel electric generator, which is pronounced by prominent electrical experts to be the best thus far invented, and is destined to supersede the Brush, Edison, and other electric light machines now in use. Instead of following the old rut of other electrical inventors, and employing an electric armature or series of armatures revolving in one direction near the field magnets, Mr. Ball employs two armatures revolving in opposite directions near the field magnets in such a manner as to require little power, and they produce results which cannot be obtained with the same power by any other generator now in the market. A Ball generator, operated by two half-inch belts, has been in practical operation in New York City for some time past, lighting six arc lamps of very intense power. The same amount of light could only be produced by a Brush, Edison, or other generator, using an eight-inch belt. The Ball generator requires about a half horse-power per arc light, while other generators require from one and a half to two horse-power per light.—*Journal of the Telegraph.*

THE CABLE SHIP *SILVERTOWN*.—On the morning of March 11th, the India-rubber and Gutta-percha Company received a telegram from Mr. M. Hamilton Gray, engineer-in-charge of the ss. *Silvertown*, announcing the arrival of this steamer at Madeira, on the 10th inst. All well. The *Silvertown*, after coaling, proceeded on her voyage to the West Coast of South America. She has on board 2,371 n. miles of cable, weighing 4,880 tons, and also, when she passed Portland on the 4th inst., 1,600 tons of coals.

THE AMERICAN RAPID TELEGRAPH COMPANY.—The American Rapid Telegraph Company is fast pushing its lines between the leading cities of the United States, and hopes within the next year to be able to transmit messages between all prominent American cities. They use what is known as the Randall automatic system, and transmit to any part of the United States twenty words for 15 cents. This company bids fair to become a strong rival of the Western Union. Skilled operators are not needed, and messages are prepared by perforators by boys and girls, who are obtained at cheap rates.

DUPLEX TELEGRAPHY.—The Western Union Telegraph Company, as assignees of the famous Stearns condenser systems of duplex telegraphing, have recently re-issued the patents granted to Mr. Stearns in 1873 in the United States, with broad claims designed to encompass all inventions since made, for overcoming static disturbances in duplexy; but it is exceedingly doubtful if the courts will sustain such broad claims in view of the recent decision of the United States Supreme Court upon re-issue patents in the case of Miller *v.* Bridge Port Brass Company, in which they deprecate the idea of enlarging the claims of patentees years after the invention, when the state of the art has materially advanced, and independent inventions have sprung up which the patentee never contemplated when his original patent was granted.

SUGGESTED SYSTEM OF OCEAN BUOYS.— M. Mennisier has recently submitted to the French Society for Encouragement of National Industry, a plan of the following impracticable nature:—Lay a telegraph cable between Saint Nazaire, Bordeaux, and New York, with branches in mid-ocean to Panama. Every sixty leagues (the average daily distance covered by a ship) connect to the principal cable a vertical cable, ending in a buoy at the surface. To the right and left of the principal cable lay two branch cables, ten to twenty leagues each, ending in a vertical cable with buoys. (These branches would form two crosses with the main cable.) The chances of ships sighting buoys would thus be frequent. Each buoy has a number, and its position in mid-ocean is known from special tables. When a ship passing near a buoy wishes to telegraph, it connects its apparatus wires, one with the wire of the buoy, the other with the buoy itself (serving as earthwire). Thus the ship might communicate with the central post, which should be established on an island or rock, or a ship moored according to M. Mennisier's system. A vessel in distress near one buoy might, through the central station, get help from a ship passing near the next buoy. The difficult matter is the buoy, and the question is asked, How would it resist storms that have broken cables? M. Mennisier has not yet described his buoy in detail, but says it is pronounced quite successful by competent navigators. It is luminous by night, sonorous in fog, and easily accessible in any weather.

REVOLVING TELEGRAPH TABLE.—An improved revolving telegraph table has been patented by Mr. John L. Garber, of Greenville, Ohio. The table is divided by glass partitions into a series of subdivisions for the several sets of instruments. Each compartment of the table requires four strips or rings of metal around the central post, a separate insulated wire leading from each ring to their respective instruments on the table, the wires being placed in a shallow groove directly back of the rings and metal collar. The central post revolves in the central hollow leg of the table, and the hollow leg is provided with a series of contact springs, consisting of a segmental plate attached to a countersunk stem fitting into a socket and pressed against the plates or rings of the central post by a spiral spring: these contact springs or their sockets are connected with the local battery or main line. To the under side of the table is fastened a perforated ring, into the aperture of which a vertical locking bar fits, which is pressed upward by a suitable spring, and can be withdrawn by depressing a foot lever on the under side of the base frame of the table.

For conveniently illuminating the different sections of the table, a lamp or gas burner is mounted at the intersection of the glass partition of the table. When the operator wishes to use any certain set of instruments he depresses the foot lever, which permits the table to be turned until the desired set of instruments is in front of the operator, who does not leave his seat. The foot lever being released, the table is locked in position. This table may be arranged for two, three, or more sets of instruments, the number of rings and contact springs varying accordingly.

The advantages of this device will be apparent to telegraphic engineers and operators. The removal or insertion of switch plugs or the turning of switches is entirely avoided, the necessary changes being made automatically as the table is turned.—*Scientific American.*

REWARDS FOR DISTINGUISHED MERIT.—The Albert Medal of the Society of Arts to reward "distinguished merit in promoting arts, manufactures, and commerce," was struck and issued for the first time in 1864, Sir Rowland Hill, K.C.B., being the recipient. From that date inclusive there have been eighteen awards of this honour, one third of them falling to the share of eminent electricians in the following rotation:—In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted arts, manufactures, and commerce." In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph." In 1873, to C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to the manufactures and the arts." In 1876, to Sir George B. Airy, K.C.B., F.R.S., astronomer royal, "for eminent services rendered to commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the application of the mariners' compass to the navigation of iron ships." In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S., "on account of the signal services rendered to arts, manufactures, and commerce, by

his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables." In 1880, to James Prescott Joule, LL.D., D.C.L., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science and industrial pursuits."—*Society of Arts' Journal.*

THE TELEPHONIC EXCHANGE SYSTEM.—We are informed that, with the object of facilitating the further development of the telephonic exchange system, the Postmaster-General has conceded to the Lancashire and Cheshire Telephone Company the right to adapt their exchange systems for general public use at existing telegraph rates. This, it may be assumed, indicates that the Government, having vindicated their right to control the extension of the telephonic system, are prepared to grant reasonable terms to the existing companies. No doubt Mr. Fawcett intended to adopt this course from the first, but the difficulty of making the necessary arrangements for securing the rights of the Government as determined in the courts of law has caused delay.

THE EFFECT OF FLAME ON THE ELECTRIC DISCHARGE. (Abstract of paper read before the Royal Society of Edinburgh, 6th March, 1882.) By Dr. A. Macfarlane and Mr. D. Rintoul.—The flames experimented with were produced by means of a Bunsen burner, and were either luminous or non-luminous; the charged body was a disc placed at the side of the flame, and the charge was of either kind. The results deduced from a methodical series of measurements and observations are as follow. *First, when the flame is of constant height and the distance of the disc from the tube is varied.* The difference of potential required to produce the spark is greater when the disc is negatively electrified than when it is positively electrified, excepting that for small distances there may be an equality or even a small difference the other way. Again, the difference of potential at the smaller distances is greater for the non-luminous flame than for the luminous, but at the greater distances it is very much the other way, particularly in the case of the negative charge. The range of distance extended to 8 centimeters. There are differences in the behaviour of the flame co-existing with these differences in electromotive force. *Second, when the distance of the tube from the disc is kept constant and the height of the flame varied.* The difference of potential required for the spark remains nearly constant when the flame is luminous and the electrification negative, the difference of potential is at first very great, and it diminishes rapidly as the height of the flame is increased, until the flame is of sufficient height to reach over to the disc. Thereafter it remains nearly constant. Though the flame be attracted so as to be in contact with the disc, the discharge still passes in the form of a spark.

ELECTRICAL THERMOMETER AND THE VERTICAL DECREMENT OF TEMPERATURE.—The council of the Meteorological Society, in experimenting on the vertical decrement of temperature, have placed thermometers at the summit and base of Boston Church Tower, which is 270 feet high. This tower is admirably situated for making such experiments, as it is isolated and free from any obstructions and the ground is quite flat for miles round. By permission of the vicar, Canon Blenkin, the instruments have been placed as follows:—at the summit, one of Dr. Siemens' electrical thermometers (kindly placed at the society's disposal by Messrs. Siemens Bros. & Co.) and an ordinary thermometer are mounted in a small screen fixed to one of the pinnacles of the tower; on the roof of the belfry, which is 170 feet above the ground, a Stevenson screen has been mounted containing maximum, minimum, dry and wet bulb thermometers. In the churchyard, another Stevenson screen has been fixed, containing a similar set of thermometers for comparison with those above. All the thermometers will be read every morning at 9 o'clock. The electrical thermometer consists of a coil of wire wound round a cylindrical piece of wood inclosed in a small brass tube; a third wire is joined to one of the wires, and the three, insulated by gutta-percha, form a light cable which is brought down to the base of the tower and connected to a galvanometer, the terminals of which are in connection with the two poles of a six-cell Leclanché galvanic battery. The instrument is read by depressing a key which causes the needle of the galvanometer to deflect; a pointer or vernier (moving a contact roller upon a wire in a circular groove) is then pushed to the right or to the left upon a divided scale, until the needle remains stationary on the zero point, when the electrical resistance of the wire is measured upon the scale. The number indicated by the vernier is then read off, and by referring to a table of equivalents the actual temperature in degrees of Fahrenheit is readily ascertained. Simultaneous readings of the electrical thermometer at the summit of the tower and of the dry bulb thermometer in the churchyard will be made frequently during the day.

DEATH OF SIR WYVILLE THOMSON.—Sir Charles Wyville Thomson, LL.D., F.R.S., died at Bonsyde, near Linlithgow, on the morning of March 10th. He was educated at Merchiston Castle and Edinburgh University. He will be best remembered in connection with the *Challenger* expedition, which was organised in 1872. Prof. Thomson was appointed head of the scientific department, and was absent in that vessel for nearly three years and a half, making a cruise of about 68,000 miles. The results obtained during this voyage have been of great value to the scientific world, and submarine telegraphy has benefited in no small degree.

CRYSTAL PALACE ELECTRICAL EXHIBITION.—On Wednesday last, we believe, Prince Edward of Saxe Weimar, accompanied by a party of the officers of the Portsmouth Garrison, visited the Crystal Palace Electric Exhibition.

THE LATEST ELECTRIC LAMP.—Mr. Edison has recently patented an arc-lamp which, it is said, avoids the unsteadiness arising from impurity of the carbon. It occurred to Mr. Edison while conversing with a friend in New York that this result might be achieved by causing the upper carbon to revolve rapidly. He tested the idea at Menlo Park, using at first a hand-wheel, and, finding this successful, he has fitted into his new lamp a small electro-motor, which makes the "candle" revolve at the rate of 3,000 revolutions a minute, and this, it is stated, insures absolute equality. The current is thus made to perform a threefold duty—to supply the light, to turn the electro-magnet, and to form the arc. This new lamp has not yet been seen in England, and it is uncertain whether it will be shown at the Electric Exhibition now being held. As attention has been drawn to this lamp in almost every newspaper, and as many of our readers may not be aware of its mode of action, we refer them to our issue of January 28th, p. 64.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.—At the next meeting of this society, which takes place on Thursday the 23rd, a paper is to be read "On the Development of a New Telephonic System," by Professor A. E. Dolbear.

ELECTRICITY AND FIRE INSURANCE.—*Engineering* says that the directors of the Crystal Palace Company, as well as their numerous tenants, stall-holders, and exhibitors, have within the last few days been served with notices issued conjointly by the various insurance companies in whose offices the Crystal Palace and its contents are insured, to the effect that, in consequence of the establishment within the building of the Electrical Exhibition, the premiums on their policies of insurance against loss by damage by fire during the next six months will be more than doubled. The Crystal Palace and its contents have for many years been charged for insurance at an excessively high rate (31s. 6d. per cent.) considering the nature of the building and the fact that it could never be totally destroyed by accidental fire, and this rate is now to be increased by 21s. per cent. for six months, making the total charge at the rate of £3 13s. 6d. per cent. per annum. The extra premium to the Crystal Palace Company for the building alone represents a sum of £2,000, or 40,000 visitors on shilling days. Could there be any guarantee from the Crystal Palace Company that the installations of the various systems had been superintended by experienced electricians, then we should think that the action of the insurance companies was entirely uncalled for; but knowing how

carelessly the majority of those engaged in such operations carry out the work intrusted to their charge, we think the companies have been advised in the right direction. If properly supervised, however, the use of the electric light should be unattended by danger from fire.

## NEW PATENTS—1882.

1132. "Improved method or means of applying earthenware tubes and pipes for the conveyance of gas, water, telegraph wires, &c." G. SMITH. Dated March 8.

1136. "Electric telegraphs." S. PITT. (Communicated by H. C. Mance.) Dated March 8.

1137. "Telegraphic apparatus, especially for street fire-alarms." W. H. DAVIES and F. H. W. HIGGINS. Dated March 8.

1139. "Dynamo or magneto-electric machines or electric engines." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated March 9.

1142. "Means for regulating the generative capacity of dynamo- or magneto-electric machines." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated March 9.

1153. "Improved substitute for gutta-percha for insulating, waterproofing, and other purposes." M. ZINGLER. Dated March 9.

1162. "Apparatus for the distribution and regulation of electric currents." W. R. LAKE. (Communicated by H. S. Maxim.) Dated March 10.

1163. "Electric lighting apparatus." W. R. LAKE. (Communicated by E. Weston.) Dated March 10.

1171. "Mechanism for regulating the burning of carbon or other electrodes in electric lighting apparatus." A. GRAHAM. Dated March 10.

1172. "Improvements in incandescence electric lamps and in apparatus employed in the manufacture of the carbon filaments." J. WANTHIER. Dated March 10.

1173. "Secondary batteries or electric accumulators." J. H. JOHNSON. (Communicated by A. de Méritens.) Dated March 10.

1174. "Generating, distribution, storing, utilisation, measuring, and regulation of electricity, and apparatus or means therefor." J. S. WILLIAMS. Dated March 10.

1177. "Telephones." J. D. HUSBANDS. Dated March 10.

1191. "Improvements relating to dynamo- or magneto-electric machines for regulating the generative capacity of such machines." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated March 11.

1195. "Improvements in relation to electric circuits and in apparatus for protecting buildings, safes, vaults, and other structures from burglars." W. P. THOMPSON. (Communicated by M. H. Kerner.) Dated March 11.

1199. "A new or improved electric lamp of the arc type." R. KENNEDY. Dated March 13.

1201. "Construction of dynamo-electric or magneto-electric and electro-dynamic machines." R. MATTHEWS. Dated March 13.

1207. "Apparatus for giving alarm in case of accidents, burglarious attempts, fires, or other like matters." C. B. WOOD. Dated March 13.

1211. "Machinery for obtaining electric currents." H. E. NEWTON. (Communicated by A. J. Gravier.) Dated March 13.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1881.

2954. "Electric machines." PETER JENSEN. (A communication from abroad by Thomas Alva Edison.) Dated July 6. 6d. The object of the first part of this invention is to produce a dynamo or magneto-electric machine in which the iron core of the armature will not be necessary, and the loss of power caused by the heating of the same will be avoided, only the inductive portion of the armature being passed between the polar extensions of the exciting magnet or magnets, which polar extensions can consequently be brought close together so as to produce an intense magnetic field. And another object is to construct a machine of this character so that it will generate a continuous current of high electromotive force in the same direction without the use of pole changers, all the inductive portions of the armature being constantly in circuit, and the internal resistance of the machine being exceedingly small. Figs. 1, 2, and 3 show the arrangement of the invention. A, B, are the electro-magnets, and $A^1$, $A^2$, $B^1$, $B^2$, the polar extensions of same; C is the driving shaft. The radial copper bars are numbered from 1 to 16 inclusive. D is the hub to which the radial bars are secured, the bars being insulated properly therefrom. Sixteen radial bars are shown for purpose of illustration, but the number might be more or less, according to the size of the machine. E represents the circular insulated plates with which the radial bars are connected, and these plates have tongues, *e*, connected with the bars of commutator cylinder, F. Two radial bars are connected with each plate, E, and by it with the nearest central commutator bar. The concentric copper rings surrounding the radial bars are lettered from $G^1$ to $G^8$ inclusive. They are connected with the radial bars by bands, straps, or rods, H, or the radial bars may be forked and inclose the rings partly, in which case H would be integral with such radial bars. The neutral line extends vertically through the centre of the armature, while the commutator brushes or springs, P, N, make contact with the sides of the commutator cylinder at the ends of the horizontal diameter, the bars next to the neutral line being connected

FIG. 1.

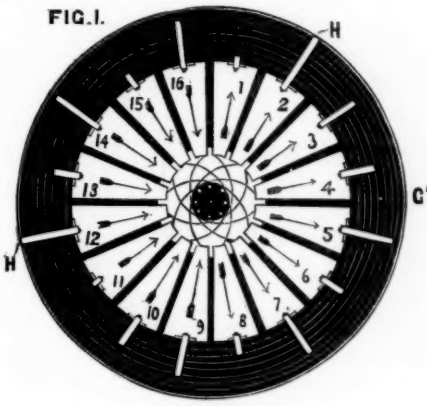



FIG. 2.

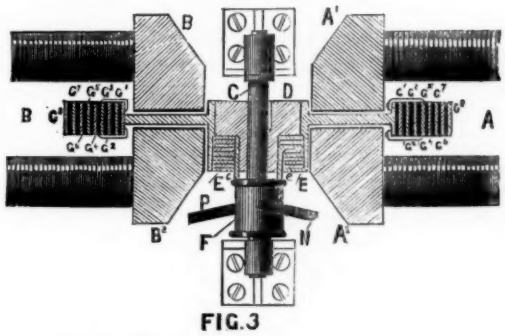
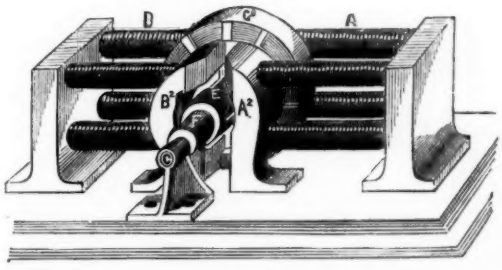



FIG. 3




with the central side commutator bars as shown. On the left hand side of the neutral line the currents in the radial bars, as shown in figure 1, all run inwardly, while those on the right hand side flow outwardly. In the position shown, one portion of the current would pass from the negative to the positive commutator brush, *via* 1 . $G^1$. 11 . 2 . $G^5$. 12 . 5 . $G^7$ . 14 . 7 . $G^6$ . and 16, and the other portion *via* 8 . $G^3$ . 15 . 6 . $G^3$ . 13 . 4 . $G^4$ . 10 . 3 . $G^5$ . and 9, the proper plates, E, and straps, H, being included in the circuits.

2989. "Apparatus for transmission of power by electricity." JOHN HOPKINSON. Dated July 7. 6d. Relates to apparatus for the transmission of power by electricity, whereby the force of dynamo-electric or magneto-electric machines may be utilised under advantageous conditions for the purposes of hoisting or raising and lowering heavy bodies, for the propulsion of vehicles, and for other purposes. In carrying out the invention as applied, for example, to the construction of a hoist, a dynamo-electric or magneto-electric machine is employed, in combination with a pulley or barrel fitted with the device known as the Weston friction coupling or clutch, the machine and the pulley or barrel so fitted being carried in a suitable frame, and arranged by preference the one over the other, and connected by toothed or other suitable gearing for transmitting motion from the machine to the said pulley or barrel, over which passes the tackle carrying the load to be raised or lowered. Any suitable capstan or windlass may be used in this arrangement. The dynamo-electric or magneto-electric machine is fitted with devices for reversing the direction of rotation of the armature of the machine. A spring or springs are employed for the purpose of automatically moving the said devices for regulating the direction of the motion of the machine to a neutral point, so that when the pulley or barrel is locked by the action of the friction coupling or clutch, on the strain being removed from the rope or chain suspended therefrom the motion of the machine shall likewise be arrested. The apparatus

is shown by figs. 1, 2, and 3. Fig. 1 represents in elevation an electric hoist for raising weights attached to either end of the chain, which hangs over the chain pulley. A dynamo-electric machine, connected with the pulley by gearing, is for convenience arranged above the pulley, the whole of the parts being carried by a suitable frame. The reversing arrangement effects the reversal of the direction of motion of the armature or revolving portion of the machine by changing the position of the points of contact of the brushes and the commutator or collector. Within the pulley, or if more convenient on any other of the shafts, is the screw of the Weston clutch. The action of this clutch in its various forms is well known. If a

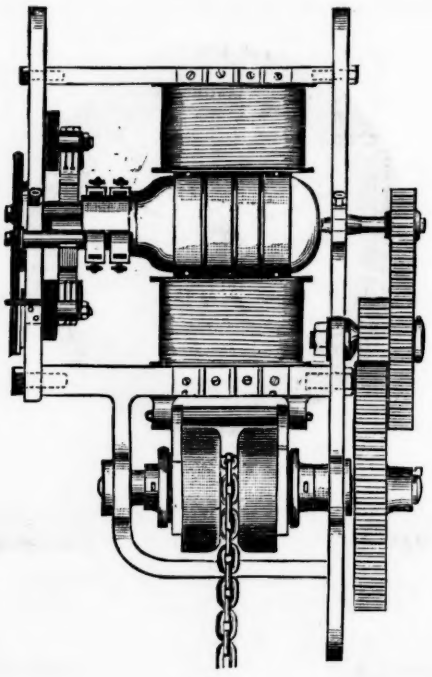


FIG. 1.

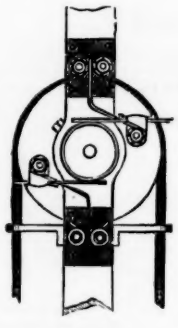


FIG. 2.

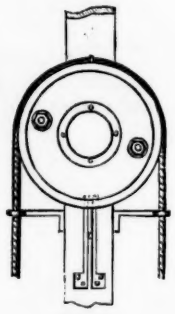


FIG. 3.

weight be hanging on one end of the chain, the pulley will turn on a screw, and will clamp itself to a ratchet wheel, which is held by detents. If the dynamo-electric machine rotates in the direction of lowering the weight the clamping action is released. Fig. 2 is a view of the reversing gear seen from the inside; fig. 3 shows the same as seen from the outside. The arrangement consists of a double spring, each limb of which presses strongly against a fixed stud. A wheel carries the holders of the brushes, which are in contact with the commutator; this wheel is moved in order to change the position of the points of contact of the brushes with the commutator, and thus start the apparatus by the act of pulling a hand cord, and when so moved in either direction the stud presses against one of the springs, at once encountering considerable resistance therefrom. When the cord is released, and the wheel consequently set free, the spring will force the system carried by the wheel into the neutral position indicated in the drawings, in which the contact pieces, electrically connected with the brushes, are situate centrally between the binding screws or terminals, and the hoist will cease to move.

3228. "Apparatus for controlling telephonic communications." JOHN IMRAY. (A communication from abroad by Leon Alexandre Brasseur and Octave Dejaer, both of Brussels.) Dated July 23. 8d. Has for its object to simplify operations at the central stations of telephonic systems, to provide against the evils resulting from induction on the line wires, and to secure secrecy of communication. For this purpose a distributing tablet is employed in connection with the commutators, and a special mode is adopted of coiling the two line and return wires on the receiving and transmitting bobbins, whereby induction is prevented, and the total resistance of the circuit is greatly reduced There is also applied to the distributing tablets and commutators an arrangement for secrecy, hereafter described, and a changeable key is used for making connection, this key consisting of two parts insulated from each other for exposed lines, and of three parts for buried lines.

## CITY NOTES.

OLD BROAD STREET.

### MONTEVIDEAN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

THE report submitted at the ordinary general meeting held at the company's offices on the 16th instant, states that the company's percentage of the gross earnings of the Western and Brazilian Company amounts for the year ending 31st December, 1881, to £2,779 7s. 11d., the December quarter being estimated at £600. After setting aside £500 for redemption of debentures, and providing for all charges and debenture interest accruing during the year, there remained a net balance of £1,102 10s. 6d., out of which it was proposed to pay a dividend of 2s. 6d. per share (£1 5s. 0d. per cent.), carrying forward a balance of £63 5s. 6d. to next account.

The meeting being purely a formal one, only one shareholder being present, the report was adopted.

### LATEST QUOTATIONS.

| Authorised Issue. | Share. | Name. | Paid. | Closing Quotations. March 15. | Business Done. |
|---|---|---|---|---|---|
| | | **ELECTRIC LIGHT.** | | | |
| 40,000 | 10 | Anglo-American Brush Co. | 4 | 8½- 9 | 8¾ ac. |
| | | Do. Do. | 10 | 21½- 22½ | |
| 150,000 | 1 | Electric Light and Power Generator Co. | 1 | ⅝- ¾ | ⅝.⅝.11-16.¾ ac. |
| | | **TELEGRAPHS.** | | | |
| 2,116,400*l.* | Stk. | Anglo-American, Limited | 100 | 52⅝-53½ | 52⅝.3.2½.½. 3½ ac. |
| 2,441,800*l.* | Stk. | Do. Preferred { Def'd. receiving no div. until } | 100 | 82½ 83¾ | 82⅝.½.2.3.½. 2½ ac. |
| 2,441,800*l.* | Stk. | Do. Deferred { 6 p. c. has been paid to Pref. } | 100 | 23½-24½ | 23½.4 ac. |
| 130,000 | 10 | Brazilian Submarine, Limited | 10 | 11 -11¼ | 11 1/16 ac. |
| 16,000 | 10 | Cuba, Limited | 10 | 8 - 8¼ | |
| 6,000 | 10 | Do. 10 per cent. Preference | 10 | 15½- 16½ | |
| 13,000 | 10 | Direct Spanish, Limited | 9 | 6 - 6⅛ | |
| 6,000 | 10 | Do. 10 per cent. Preference | 10 | 15½ 16⅝ | |
| 65,000 | 20 | Direct United States Cable, Limited, 1877 | 20 | 11¼-11½ | 11¼ ac. |
| 100,000*l.* | 100 | Do. 6 per cent. Debenture, repayable 1884 | 100 | 100 -103 | |
| 380,000 | 10 | Eastern, Limited | 10 | 10 - 10½ | 10¼ m. |
| 70,000 | 10 | Do. 6 per cent. Preference | 10 | 12½- 12¾ | 12¼ ac. |
| 232,000*l.* | 100 | Do. 6 do. Debentures, repayable Oct. 1883 | 100 | 101 -104 | |
| 200,000*l.* | 100 | Do. 5 do. do. Aug. 1887 | 100 | 100 -103 | |
| 200,000*l.* | 100 | Do. 5 do. do. Aug. 1899 | 100 | 102 -107 | |
| 199,750 | 10 | Eastern Extension, Australasia & China, Limited | 10 | 11 - 11⅛ | 11 1/16 m. |
| 320,000 | 100 | Do. 6 p. c. Debentures, repayable Feb. 1891 | 103 | 105 -109 | |
| 500,000 | 100 | Do. 5 p. c. (Australian Gov. Subsidy) Deb. 1900 | 100 | 102 -105 | |
| 140,000 | 100 | Do. do. registered, repayable 1900 | 100 | 102 -105 | |
| 100,000*l.* | 100 | Do. 5 per cent. Debenture, 1890 | 100 | 102 -105 | |
| 254,300*l.* | 100 | { Eastern and South African Limited 5 per cent. } { Mort. Deb. Registered redeemable 1 Jan. 1900 } | 100 | 101 -104 | |
| 345,700*l.* | 100 | Do. do. To Bearer | 100 | 101 -104 | |
| 22,050 | 10 | German Union Telegraph and Trust, Limited | 10 | 9¼- 9⅝ | |
| 163,390 | 10 | Globe Telegraph and Trust, Limited | 10 | 6¼- 6⅝ | 6¼.1/16 ac. |
| 163,209 | 10 | Do. 6 per cent. Preference | 10 | 12½- 12⅝ | 12 1/16 ac. |
| 125,000 | 10 | Great Northern | 10 | 12 - 12½ | |
| 100,000*l.* | 100 | Do. 5 per cent. Debentures | 100 | 101 -104 | |
| 31,200 | 10 | India-Rubber, Gutta-Percha and Telegraph Works | 10 | 24¼- 25¼ | 24¼m. 25¼a |
| 100,000 | 100 | Do. 6 per cent. Debentures, 1886 | 100 | 104 -108 | |
| 17,000 | 25 | Indo-European, Limited | 25 | 28 - 29 | |
| 38,148 | 10 | London Platino-Brazilian, Limited | 10 | 4⅜- 5½ | |
| 12,060 | 10 | Mediterranean Extension, Limited | 10 | 1⅞- 2⅛ | |
| 8,200 | 10 | Do. 8 per cent. Preference | 10 | 8⅜- 9⅛ | |
| 9,000 | 8 | Reuter's, Limited | 8 | 12⅞- 13⅜ | |
| 280,000 | Stk. | Submarine | 100 | 260 -270 | |
| 58,225 | 1 | Do. Scrip | 1 | 2⅛- 2⅜ | |
| 4,200 | Cert. | Submarine Cables Trust | 100 | 100 -103 | |
| 37,350 | 12 | Telegraph Construction and Maintenance | 12 | 29 - 30 | |
| 150,000 | 100 | Do. 6 per cent. Bonds, 1884 | 100 | 101 -105 | |
| 186,750 | 5 | Do. 2nd Bonus Trust Cert. | 5 | 1⅛- 1⅜ | |
| 30,000 | 10 | West Coast of America, Limited | 10 | 4⅞- 5⅛ | |
| 150,000 | 100 | Do. 8 per cent. Debentures | .. | .. | |
| 69,910 | 20 | Western and Brazilian, Limited | 20 | 8⅛- 8⅝ | |
| 200,000*l.* | 100 | Do. 6 per cent. Debentures "A" 1910 | 100 | 105 -110 | |
| 2,500 | 100 | Do. 6 p.c. Mort. Deb. series B of '80. red. Feb., 1910 | 100 | 98 -101 | |
| 1,500 | $1,000 | Western Union of U. S. 7 p.c. 1 Mort. (Building) Bds. | $1,000 | 123 -128 | |
| 1,030,000*l.* | 100 | Do. 6 per cent. Sterling Bonds | 100 | 101 -104 | |
| 88,321 | 10 | West India and Panama, Limited | 10 | 1⅛- 1⅜ | |
| 34,563 | 10 | Do. 6 per cent. 1st Preference | 10 | 7⅛- 8 | |
| 4,669 | 10 | Do. 6 do. 2nd do. | 10 | 6 - 6½ | |
| | | **TELEPHONES.** | | | |
| 154,165 | 1 | Con. Telephone & Maintenance, Ld. Nos. 1 to 154,165 | 1 | 1⅛- 1⅜ | |
| 200,000 | 1 | Oriental Telephone Co. | ⅛ | ⅛ | |
| 100,000 | 5 | United Telephone Co. | 5 | 13¼- 13⅝ | 13⅜.¼.⅝.⅜ |

### TRAFFIC RECEIPTS.

Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of February was 3,347, estimated to produce £3,200, against 2,692 messages, producing £2,867, in the corresponding month of last year. The traffic receipts for the month of December, estimated at £2,500, realised £2,741.

Brazilian Submarine Telegraph Company. The receipts of this Company for the week ending March 13th, amounted to £3,915.

The Western and Brazilian Telegraph Company, Limited. The traffic receipts for the week ending March 10th, 1882, were £2,722, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.